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THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

THIS growing and useful Association, for which we have no counterpart in Europe, has held its eleventh semi-annual Convention at Kansas City, and, like its forerunners, it was in every way successful, interesting and instructive. Special trains, for long distances, have always been run for the convenience of delegates, and we remember some very enjoyable Convention rides on two occasions, but the recent "electric limited train is considered the finest train ever drawn out of Jersey City." It carried a party of electrical men, starting from Jersey City at 10.20 a.m., February 9th, and reaching Chicago within 26 hours. The carriages were lighted by electricity as a matter of course, the plant consisting of a Brotherhood engine, an Eickmeyer dynamo, and 32 secondary battery cells of the New York Accumulator Company. The delegates were received by the Chicago Electric Club, one of the most hospitable institutions of that city; and, after a luncheon, followed by speeches, the party again entrained at 4.30 p.m., wending their way south-west towards the neighbouring State, Missouri.

The National Electric Light Association consists of corporations, firms and individuals, owning and operating stations and plants for the distribution of electric energy. It is not a scientific body, and the papers read and discussed are mostly of a practical and commercial nature. In February, 1885, at the inaugural meeting, the Association had 87 enthusiastic members; now it has 304 representatives of almost every territory, and all the leading electric systems in the United States.

Special committees appointed by the Convention meet at frequent intervals all the year round to consider important questions, collect data or statistics, and present exhaustive reports to the Association meetings. On examining the list of members present at Kansas City we could not help noticing that many prominent American electricians were conspicuous by their absence, and we also observed a goodly number of new names. This may probably be explained by the fact that the place of meeting was too far away for some of the Eastern section, and on previous occasions many Western men who attended this time could not spare the time to travel to the Conventions of New York, Philadelphia, Boston, Niagara Falls, Pittsburgh, and other cities.

As a rule, the Mayor of the city honoured by the Association gives an address of welcome, and virtually opens the proceedings, setting forth the advantages of such meetings, and giving some general statistics on the progress of the electrical industry during the previous six months. Mayor Davenport gave the following interesting figures :—"It is estimated that at the beginning of the year 1890 about six hundred million dollars were invested in the electrical industries in the United States, and that 250,000 persons depended upon it for their means of living; that a million miles of telegraph wires were in operation; 300,000 telephones were constantly talking, and an average of 1,055,000 messages were sent daily, requiring the use of 170,000 miles of wire. The longest distance over which conversation is maintained is 750 miles, from Portland, Me., to Buffalo, N.Y. Four hundred miles of electric railway are in active operation in America. The fastest speed attained in the transportation of passengers has been 20 miles per hour. I believe Mr. Weems has quite recently at Laurel, Md., upon an experimental track, made two miles a minute, or 120 miles per hour. There were no passengers upon that train, it being used exclusively for baggage, which is hereafter to be sent in advance. At the annual meeting at Niagara Falls, the statement was made that there were in use in the United States 237,017 arc lamps and 2,704,768 incandescents. Danger to human life and property interests are questions in which we are all concerned; but it will not do to condemn without comparison and in-

vestigation, else we may deprive ourselves of valuable agencies and servants, which to understand is to bring us health, wealth, and prosperity. Immense poles, that make unsightly our most beautiful thoroughfares, over which hang a dense mass of wires to obstruct access to our buildings in case of fire, and almost shut out the light of day, will in time disappear. It was necessary that they should precede the subways now coming into use, but not yet, I believe, admitted to be universally successful, though the Bell Telephone Company had in 1887 6,030 miles of wire underground ; in 1888, 8,009 ; and, in 1889, had increased it to 17,038 miles. Taking into consideration, however, the service performed and work done through the means of this unseen power, it is pleasing to note that the casualties resulting from its use are less than from any other service."

We cannot, at present, do more than give a list of reports of special committees and titles of papers read. Some of these are only of local interest, others contain some valuable points to which we shall return in due course. There were no less than five special committees composed of experts in their respective branches, giving reports which were followed by lively discussions. These reports referred to :—"Standardising of Potentials ;" "Harmonising Insurance and Electric Light Interests ;" "Committee on Data ;" "State and Municipal Legislation ;" and last, but not least, the Executive Committee of the Association. The following papers were read and discussed :—"Construction of Central Stations," by C. J. H. Woodbury ; "The Steam Engine," by F. E. Sickles ; "Economical Generation of Steam," by G. H. Babcock ; "Development of Generating Stations for Incandescent Light and Power," by C. J. Field ; "A System of Station Accounts," by T. Carpenter Smith ; "Cost of Products to Central Stations," by A. J. De Camp ; "Nine Years with the Arc Lamps," by M. D. Law ; "Carbon Tests," by E. F. Peck ; "How Our Paths may be Made Paths of Peace," by H. W. Pope ; "Safety and Safety Devices in Electric Installations," by Prof. Elihu Thomson ; and "Electricity as Applied to Electric Railways," by F. J. Sprague.

These papers cover a wide field, some of them have a curious title, only understood and appreciated by the "initiated," but nevertheless, of peculiar interest. As usual there was an exhibition of electrical apparatus and sundry social gatherings. We have on previous occasions attempted to draw comparisons between the National Electric Light Association and some of our own institutions, but we cannot find sufficient similarity, unless it is the Iron and Steel Institute. Virtually it is within the province of the electrical section of the London Chamber of Commerce to do what our American friends accomplish every six months ; but there is not the same hearty co-operation, the essential *esprit de corps* is wanting. The Institution of Electrical Engineers, like the Civil Engineers, has a more scientific tendency, and cannot enter into questions such as are discussed by the American Association, however important they may appear to the trade, and even to the nation at large.

AUTOMATIC ALARM SIGNALS.

WITHIN the last few years the introduction of automatic electric alarms for fire and other purposes has made very considerable progress in this country ; this has more especial reference to fire-signals, for although the application to purposes other than fire has been making progress, the latter has been but slow. Visitors to the States who are observant seldom come back without remarking upon the apathy which characterises the British citizen in adopting such every-day conveniences as they state are met with in all American towns of any size. The use of automatic signallers for summoning messengers, policemen, cabs, &c., which is said to be so common on the other side of the Atlantic, practically does not exist here. Why is this the case ? In London, at least, it is not because no one has had the enterprise to offer such a system to the public, for the Exchange Telegraph Company has for some time past rented out call-signal apparatus, but the Company has, we believe, met with but poor success, the number of subscribers being very small, and not increasing, although the rentals charged are moderate, and the apparatus thoroughly efficient. Climatic reasons affecting the temperament may have something to do with this, for we have heard it more than once stated that the feeling of briskness which in this country prompts a business man to put on his hat and run out of his office, to carry out any transaction he may desire with his client in the neighbouring street, does not affect our American cousins to the same extent, and consequently they prefer to store up their superfluous energy, and transact by telephone. Possibly, also, the cheapness of office-boy labour here renders even the moderate rental of an automatic signaller an unnecessary expense. Fire alarms are meeting with more success, and their number is being considerably increased ; in London, the County Council, we believe, intends to considerably augment the existing number of alarm posts ; but it will take some time, we imagine, before the percentage of posts per head of population bears a proportion which in American and Continental towns is considered to be a reasonable one. The police and fire alarm system, which has now been in use in the North of London for some little time, has, we understand, proved very useful and efficient, though the area over which it extends is, perhaps, hardly sufficient to give full scope to its capabilities ; that it has been successful, however, may be indicated by the fact that a rival system, a description of which will be found in our columns, is being brought to public notice. The new apparatus is claimed to possess many important advantages, the proof of which must be left to time. It is possible that the wide introduction of the automatic supply machines, which are now met with in every railway station and almost at the corner of every street, has stimulated the public taste and readiness for investing in automatic appliances, and that, consequently, a company for introducing apparatus of the fire alarm description may have a fair share of success, especially at the present juncture.

The Hertz Theory.

IT does not appear that the deductions which M. Hertz has been led to formulate from his beautiful experiments are to go unchallenged. The identity of electricity with light, which his labours seemed to demonstrate, must be looked upon with distrust if the results obtained by MM. Sarasin and de la Rive are correct. Dr. Lodge might investigate the matter anew with resonators of various kinds.

When Shall We Say the Same?

"THERE are now established in nearly every town and city central stations for supplying arc and incandescent lighting. The managers of these central stations have found it to their advantage to operate a portion of their plants for the distribution of power by means of electric motors." There is scarcely any need for us to remark that these paragraphs refer not to England but to the States, and they are quoted from a beautifully compiled pamphlet on the Thomson-Houston motor. The day may come, but it advances but slowly, when English electrical firms can introduce their goods to the notice of the public in the same strain; in the meantime we can only congratulate our American cousins upon the vast expanse of country under their control which leads to the numberless great electrical enterprises of which we hear almost weekly, the electro-motor industry now bidding fair to rival that of electric lighting.

Electrical Transmission of Power.

IN pondering further over Mr. Yorke's idea for distributing electricity which was described in our last issue, we have come to the conclusion that there may be an advantage in using alternating current machines in the manner claimed if the tension is exceptionally high. It is a matter of history that many of the experiments of M. Marcel Deprez on the electrical transmission of power failed because the commutators of his machines could not withstand the high pressure, or, in other words, the commutator sections could not be kept insulated. That recent improvements have partly cured this evil we admit, for there are many machines of the continuous current type in daily operation employing a higher potential difference than that made use of by M. Deprez, yet for still higher tension there is, we think, an advantage attached to machines which do not possess that weak point of continuous current dynamos, a commutator.

Alternating Current Motors.

THE Commission of Experts appointed by the Municipal Authorities of Frankfort to consider the best methods to be adopted for electrically lighting the city have evidently given careful study to the question. The experiments quoted on pp. 224—225 of our last issue are the most interesting examples of what the alternating current motor is capable of accomplishing even in this early stage of its career that we remember to have seen, and the continuation of the report will, we think, be awaited with much interest. Certainly the tests are calculated to give satisfaction to the advocates of alternating current transmission of power, and to encourage them to still greater efforts to secure the best possible results.

Coad's Battery.

A DESULTORY correspondence is going on in the pages of a contemporary, on the merits, or rather the demerits, of Coad's battery, and the inventor not only shows himself possessed of profound electrical knowledge but also of literary gifts with which we had not hitherto credited him. One of his critics he openly accuses of being "a snake in the grass," in others he recognises the rival's touch to depreciate the value of his work, and all who have spoken unfavourably, or at least doubtingly, of the Coad battery, he places in the category of disappointed rivals, cavillers and contemptible doubters and failures (*sic*). It seems highly problematical whether anything which can be said or written will ever convince Mr. Coad of the error of his ways, and it is indeed sad to see how fondly he clings to the assertion that the famous lens which he applies to his miners' lamp will magnify a half candle-power light into that of ten. His mathematical powers, which he darkly hints have led him to the construction of this fearfully and wonderfully made piece of glass, are evidently of the higher order.

Electric Oscillations.

THE article which we publish on another page on electric oscillations in rarefied air without electrodes, will probably prove interesting to both Prof. Oliver Lodge and Mr. Crookes. The original article does not show very clearly in 2, whether the air turns dark red in the inner or outer tube, but of course the former is meant, but the experiments of Mr. Moser are exceedingly simple and could readily be reproduced.

A Timely Offer.

SIR DAVID SALOMONS has made the munificent offer of £1,000 to found a scholarship of £35 per annum, to be held for three years, and to be entirely under the control and at the disposal of the Institution of Electrical Engineers. The Council has gratefully accepted the offer, and has appointed a committee to consult with Sir David and settle all the details in connection with the scholarship. Everybody having the pleasure of Sir David Salomons' acquaintance is aware that he does nothing for mere self-glorification, and this disinterested action on his part deserves the hearty commendation of all who desire to see Electrotechnics take a foremost place amongst the great industries of this country. We trust that his munificent offer may be productive of much good amongst the budding Faradays of the electrical profession, and stimulate the desire for more original research than has been noticeable of late years.

Battery Resistances.

WITH reference to our remarks in our last issue as to the change in the resistance of batteries which takes place when the current passing is varied, we may add that a confirmation of this law is given in a paper on "Charging Secondary Batteries," by Mr. W. H. Preece, which appeared in our issue of May 30th, 1885. It was there shown that as the current passing varied from 4·39 to 7·25 to 15·84 to 25·07 ampères, the resistance of the cells diminished from ·7608 to ·4607 to ·2816 to ·1969 ohms. In the paper in question it was pointed out that the diminution was not caused by temperature. It is obvious now that in stating what the resistance of a battery is, a note should be made of the strength of current passing at the time the test is made.

THE INTRODUCTION OF THE ELECTRIC LIGHT IN FRANKFORT-ON-THE-MAIN.

[FROM A CORRESPONDENT.]

(*Continued from page* 225.)

Hence, in case of the continuous current motor, a maximum limit of load is not so rigidly prescribed as in that of the alternating current motor, and the latter, as regards its behaviour when overloaded, is decidedly less advantageous.

As regards their applicability for domestic purposes and for the smaller industries, we may refer to what has been already said. In the use of alternating current motors for working tram lines, their inability to bear over-loading beyond a certain limit is important. In starting a tram car a much greater tractive power is needed than in normal running. To obtain this great initial tractive power with an alternating current motor of the kind examined without intermediate mechanical appliances would require a motor of a correspondingly larger type than suffices for ordinary working. Still, there are mechanical means for overcoming this difficulty with alternating current motors suited for the normal working of the car. A plan for solving this problem has been laid before us, and it justifies the assertion that the alternating current motor can be utilised for working tram lines by the addition of certain mechanical appliances.

As the continuous current motor is adapted for working tram lines without any addition, it is in this respect superior to the alternating current motor examined.

It must here not be forgotten that the motor in question is only the second which has hitherto been completed.

Question III.

(*a*) How high is the degree of efficiency of alternating current transformers for different yields of work?

(*b*) Is a demand above the normal yield possible and up to what limits?

(*c*) Can an automatic introduction and removal of alternating current transformers be so arranged that on a change in the consumption of current an optimum degree of efficiency can always be attained by adjusting the number of transformers introduced into the group concerned according to the consumption of the current?

(*d*) Is the guarantee for permanence which has been presented, and is it capable of being carried out?

The practical degree of efficiency of the alternating current transformers, by Ganz & Co., of a medium size amounts, according to experiment, when fully loaded, to 95—96 per cent.; if half loaded to 93—94 per cent.; if loaded one-fourth to about 90, and one-eighth to about 80—82 per cent. Below that point it falls off rapidly as the load decreases.

As the normal performance of Ganz & Co.'s alternating current transformers we must take that performance which the motor can permanently yield without its temperature rising at the hottest point higher than about 100° C. This, if the room has a temperature of 20° C., equals a rise of 80° C. in the apparatus.

This rise of temperature, corresponding to the normal performance, can be considerably reduced by providing the transformer rooms with a powerful ventilation. In this case the apparatus can bear, for a short time, a very considerable rise of its performance.

As in urban lighting installations the maximum demand for light lasts only for a relatively short time it seems advisable in selecting the size of the transformers to bear this point in mind, and not to select too large transformers, thus effecting the greatest possible economy both in the first cost of the transformers and in their working.

In order to keep the duty of the transformers within the limits of their best efficiency during the time of the least consumption of current (in the day and late at night) it is best to have an automatic arrangement for inserting and withdrawing each transformer. To effect this it is proposed to apply the transformers not singly, but united in groups. The number of the active transformers in each group is so adapted to the demand for light that each transformer works with its full load, and, consequently, at its best degree of efficiency. An automatic apparatus for this purpose has been shown by Ganz & Co. Repeated experiments have convinced us that it works admirably, safely, and without the production of sparks. The cost of such apparatus, as quoted by Ganz & Co., and the expense of working vanish in comparison with the sum total of the installation.

The written guarantee of Ganz & Co., as concerning the alternating current transformers, has been laid before us. Ganz & Co. are prepared to keep the transformers furnished in good order for any length of time at a yearly charge of 6 per cent. on the cost price. The assumption as to the duration of the transformers as contained in this proposal seem correct, according to the present state of our knowledge. If the transformers are found to last longer, the city can renounce the guarantee, and obtain more favourable terms.

Question IV.—Arc Lights.

(*a*) In what proportion are the mean special luminosities of a continuous current, and of an alternating current arc light, for an equal consumption of energy measured at the terminals of the lights, and what is the relation of the effect of both lamps to each other in enclosed rooms and in open spaces?

(*b*) Are alternating current arc lamps necessarily attended with unpleasant noises, so as to make them unfit for practical use?

(*c*) What is the consumption of carbons with both kinds of lights?

(*d*) What is the total cost of the alternating and of the continuous current arc lights (according to *a* and *c*), on the assumption that the energy supplied costs 8 or 6 pfennig (100 pfennig = 1 sh.) per 100 watt-hours?

In opposition to the numerous and very contradictory assertions as to the difference in quantities and the distributions of light given by alternating current and continuous current arc lamps, the Commission carried out some experiments so as to obtain a fairly accurate and practical value for the proportion of the mean special illumination of the two kinds of lamps. Accurate photometric determinations of the intensity of the light emitted by both kinds of lamps in different directions would have required more time than was at the disposal of the Commission.

In order, therefore, to determine the illuminating effect of both lamps for rooms, the Board of Works (Bau Amt) had fitted up two contiguous shops, equal in size, alike in shape, and of the same colour within, and provided on the north side with two show windows each. One of these two spaces was lighted up with a Schuckert continuous current arc lamp, and the other with an alternating current arc light by Ganz & Co. Each lamp was suspended at the same height from the middle of the ceiling.

These lamps were set in normal action, care being taken that both, inclusive of the so-called "steadying resistance," consumed almost exactly the same electrical energy. The Schuckert lamp worked with 5·8 ampère and 56·3 volt tension at the terminals. The Ganz lamp consumed on the average 330—335 watts, with a current of 8·1 ampère. Whilst three observers read off the data needed for calculating the energy consumed in both lamps, the five members of the Commission, each independently, valued the proportion of the luminosity of the two shops, comparing the two west sides, the two south sides, the two east sides, the two ceilings, and the two floors, each surface being repeatedly compared by each observer. The mean proportion of illumination of the five pairs of surfaces compared could, therefore, be taken approximately as the proportion of the mean special illumination of both lamps. As the luminosities to be compared did not differ greatly, and as the majority of the observers had

acquired experience and accuracy, by frequent photometric practice, in valuing differences of light, it was to be expected that their conclusions would not differ very widely from each other.

In these observations it was found that the small alternating current lamps did not give so white a light as the small continuous current lamps.

With alternating current lamps for stronger currents this difference did not appear.

The conclusion of the five observers was that the mean special illumination of the alternating current lamp was to that of the continuous current lamp as 1 : 1·23 (approximately as 4 : 5).

The lamps used in these trials had been supplied respectively by the firms Schuckert & Co. and Ganz and Co., who had been requested to construct their lamps normally, and who declared at the close of the trials that the lamps had burnt normally during the whole time.

For examining the open air effect of the two kinds of lamps four high masts had been erected at the corners of a square plot of level ground, each mast supporting a lamp. The two southern masts carried alternating current lamps by Ganz & Co., and the two northern masts continuous current lamps by Schuckert and Co. The height of the lamps from the area to be illuminated was arranged according to the instructions of both firms.

In the experiments the four lamps were regulated in such a manner that they consumed the same electrical energy between their terminals. The Schuckert lamp, worked with 11·8 ampères, and a tension at the terminals of 55 volts, consuming, therefore, 650 watts. In order to bring the consumption of energy of the Ganz lamp to the same level it had to be fed with a current of about 16·4 ampères. After thus obtaining an equal consumption of energy, the attempt was made to value the mean difference of the illumination of the ground by the two kinds of lamps, as well as the circumstances permitted. According to the unanimous judgment of the Commissioners, the mean illumination of the ground given by the alternating current lamp fell short of that of the continuous current lamp in the proportion of 4 : 5.

It appeared that, in order to consume equal energy, the alternating current lamp had to work with a strength of current in excess of that assumed as normal for the carbons, so that the above result is not directly applicable for calculating the illuminating effect.

If the above fact, and the further theoretical and practical considerations relating to the utilisation of that moiety of the light which is radiated upwards in the alternating current arc lamp, we may assume that for an equal expenditure of energy the brightness of the two lights is about as 4 : 3.

It was at once seen that in the alternating current arc lamp the chief emission of light does not take place horizontally ; on the contrary, the horizontal radiation has the lowest intensity ; and the distribution of light in the alternating current lamp differs from that in the continuous current lamp in the circumstance that in the latter almost the entire light falls downwards at angles of 40° to 60° with the horizon, whilst in the alternating current lamp half the light falls obliquely upwards and half obliquely downwards. Thus, in an alternating current arc lamp there exist two conical surfaces of maximum eradiation, the one downwards and the other upwards at approximately equal angles to the perpendicular.

Hence for an equal consumption of energy the performance of an alternating current arc lamp is less indoors by 20 per cent. and in the open air by 25 per cent.

(To be continued.)

Swedish Telegraphs.—We learn with regret that M. Nordlander, Director-in-Chief of Swedish Telegraphs, has at his own request been released from his duties, his resignation having been accepted by Royal decree, dated the 24th of January last.

SOME EFFECTS OF LARGE CURRENTS.*

By GEO. M. HOPKINS.

DURING some of the earlier experiments with electricity as a motive power for railways, in which the rails were employed as conductors of the current, it was observed that the wheels which received the current from the rails had an enormously increased traction while the current passed. This was at first attributed to the direct action of the current, then to molecular change caused by the electrical heating of the surfaces in contact, but the phenomenon has never been fully explained.

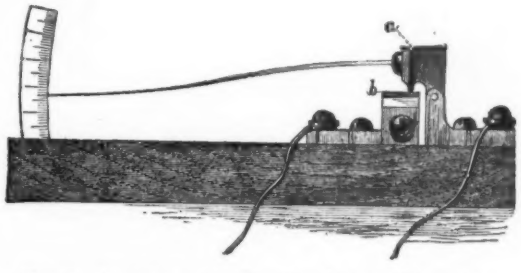


FIG. 1.—APPARATUS FOR SHOWING LOCAL EXPANSION.

The contact between the wheel and the rail under the conditions of actual use upon railways is scarcely more than a short line. If the surfaces were perfect as well as infinitely hard and rigid, the contact would be simply a mathematical line. In reality the surfaces in contact are very small, so that any current meeting the resistance of such a contact must produce some heat, which becomes greater as the current is increased. Experiments show that a current of several ampères, having a pressure of one volt or less, is required to secure good results.

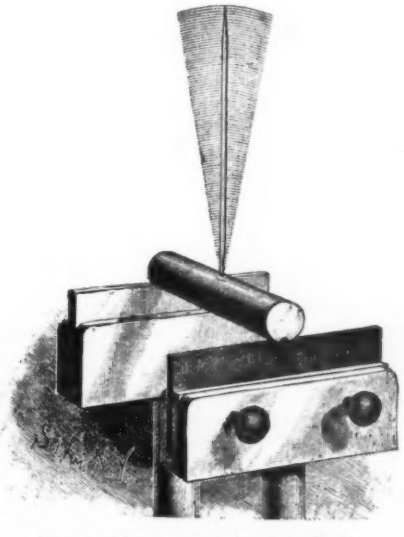


FIG. 2.—ROCKER FOR APPLIED HEAT.

Some interesting facts in regard to the local effects of large currents may be demonstrated by means of the simple apparatus shown in Fig. 1, in which a long pivoted index carries a jaw for holding a metal plate, *a*, the edge of which rests at right angles upon the edge of a metal plate, *b*, held by the fixed jaw. The free end of the index extends partly over the face of a

* *Scientific American*

scale secured to the base of the instrument. The two jaws are insulated from each other and connected by wires with a secondary battery or other source of electricity capable of supplying a six or eight ampere current with a pressure of from one to two volts. When this current passes through the metal plates held by the jaws, the parts in contact expand instantly, as shown by the upward movement of the index; and when the current ceases the plates immediately contract, allowing the index to drop. Although the distance through which the index moves is small, it is measurable, and when the minuteness of the portion of the metal actually expanded is considered, it is seen that the expansion is very great. Different metals are not all affected in the same degree. As would be expected, the effect of the same current on good conductors, such as silver and copper, is less than it is on iron and German silver.

The molecular changes effected in the metals are analogous to those produced in the lead of the Trevelyan rocker. In this instrument, however, the expansion takes place in one only of the pieces of metal in contact, the other piece being contracted by the withdrawal of the heat by the cold metal.

The form of Trevelyan rocker shown in Figs. 2 and 4 has been designed with special reference to the comparison of the effects of heat from an external source, and heat generated within the metal by the passage of a current through a point of resistance. The clamps mounted upon the upright metal rods are arranged for holding plates of different metals. The rocking bar, which rests upon the edges of these plates, is of cylindrical form. In the side of the bar, at one end, is formed a narrow groove leaving ridges which rest upon the edge of one of the metal plates. In Fig. 2, the dark plate is lead. The rocking bar, of brass, is provided with a light index to show the vibrations. When this bar is heated by means of a flame, and placed upon the edges of the metal plates, with the ridges in contact with the lead plate, it rocks violently, and if the index be removed, the rocker gives forth a musical note, which continues until the heat of the bar is reduced below the operative limit. This action is due to the local expansion of the lead by contact with the ridges of the heated bar and the subsequent rapid cooling of the lead on the separation of the surfaces. These operations occur with great rapidity; the two ridges alternating in the production of the effects.

If, after cooling the heated parts, a heavy current is passed through the standards, the plates and the bar, the same vibratory motion is at once set up, and while, in the case of the Trevelyan rocker, lead seems to be the only metal available for one of the surfaces, in the electrical rocker the results are the same in kind, although different in degree, with all the metals and alloys tried thus far.

To render the movements clearly visible, a pendulum is applied, as shown in Fig. 4. The ring at the upper end of the pendulum rod is provided with a set screw, which allows it to be shifted from one rocking bar to another. This arrangement also permits of placing the pendulum and bar in working position,

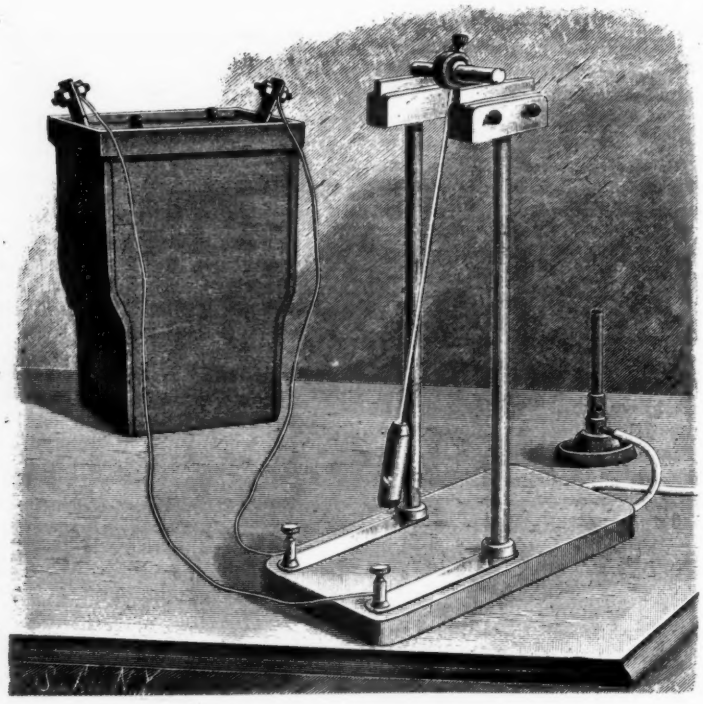


FIG. 4.—PENDULUM ROCKER.

without the necessity of levelling the base of the instrument. The current from one small cell of secondary battery or from two large bichromate cells connected in

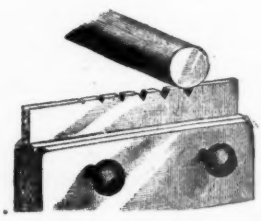


FIG. 3.—MODIFIED ROCKER.

parallel circuit is sufficient to cause the pendulum to begin to oscilate from a state of rest, and to increase its amplitude of vibration until it describes an arc of about 30 degrees. The heat generated by the current is con-

ducted away so rapidly as to permit of continuous operation.

By raising the pendulum so as to bring the convex side of the rocking bar into contact with the edges of the plates, and drawing the bar along lengthwise of the plates, first without the current and afterwards with the current flowing through the apparatus, a great increase in friction will be noticed as the current passes, the increased friction being due to the jutting out by expansion of points upon both the edges of the plates and the side of the rocking bar.

In Fig. 3 is shown a slightly modified form of rocker in which a plate with a graduated series of notches is used in connection with a cylindrical bar.

In the case of the rocker with the attached pendulum the taps of the rocker upon the edge of the plate are as distinct and regular as the ticks of a French clock.

SECTIONAL CONDUCTORS FOR ELECTRIC TRAMWAYS.

By W. E. AYRTON.

IN the last issue of the ELECTRICAL REVIEW there appears a report, drawn up with a great flourish of trumpets by three English engineers, on a system of sectional conductors for electrical tramways, which is called "The Wynne Electric Tramway System," by means of which "power is transmitted from the engine to the car as directly as by rope traction, without the objectionable necessity of cutting a continuous slot in the roadway."

It is mentioned in the editorial remarks on this American system that it does not possess that startling novelty Mr. Wynne and the reporters imagine, but it is not stated that the detailed methods described by Prof. Perry and myself in our patent specifications of Nos. 783 of 1881 and 2,395 of 1883, were orginated for carrying out several years ago *by practically exactly the same means, the precise idea* that constitutes Mr. Wynne's invention of 1890, and that therefore, in the expressive language of his country, his proposal is a "chestnut."

The system is for the purpose of working even a long electric tramway, or railway without the necessity of having either :—

1. The leakage from rail to rail that occurs with a line like the Brighton electric tramway.

2. Or an overhead insulated bare conductor rubbed along its whole length by a carrier pulled along by the moving car ; the system now commonly adopted in America.

3. Or a well-insulated conductor raised a few feet above the ground and rubbed by a shoe attached to the moving car, as at Portrush.

4. Or a continuous slot in the road, as at Blackpool.

The former of the two patents mentioned above, viz., that for 1881, covers and describes methods for attaining this result by the use of :—"Our improved apparatus consists of an insulated wire, cable, or other conductor or conductors, placed either alongside, above, or underneath the railway, or in any other suitable position, and the insulation of which is maintained by gutta-percha, India-rubber, &c., or by paraffin or other oils, or by its being supported on insulators. This conductor, or conductors, is automatically, or at will, by a signalman or other person, electrically connected successively to one or more sections of a rail in the neighbourhood of the moving train. This rail, which may or may not be that on which the train runs, and which may be rigid or somewhat elastic, is divided into sections fairly well insulated from one another and from the earth, &c."

Then it is explained that the insulation of a conductor on the ground, as, for example, the ordinary rail, is sufficient, in certain cases, to enable it to be used as the sectional conductor "dividing and insulating the said rail at the usual fish plate or other joint into sections of suitable length."

The devices described in detail in the 1881 specification for automatically connecting in succession the main well insulated cable with the various sections of the rubbed conductor are worked mechanically ; but, quoting from the patent :—"We do not restrict ourselves only to the specified means of effecting contact between the rubbed rail and the well insulated conductor, inasmuch as our improvement consists essentially in employing only a short part or parts of the sectionally insulated rubbed rail as conductors at any one time, viz., those to which the travelling carriage is nearest." Further on this specification states : "Instead of the mechanical plungers we may use electric means for this purpose . . . or we may employ a magnetic arrangement depending for its action not on the weight of the train, but on its magnetic mass." This latter is the plan *subsequently* brought out by Mr. Binswanger, whose name is mentioned in the editorial remarks.

The second of our two patents referred to above, viz., 2,395, of 1883, the provisional specification of which is illustrated with 24 drawings, and the final with 31, is wholly occupied with descriptions of numerous methods for carrying out Mr. Wynne's idea of automatically, or at will, making a connection *electro-magnetically* between the well-insulated conductor and one or more of the sections of the rubbed conductor which are in the neighbourhood of the moving train.

This specification even describes, in the following words, Mr. Wynne's device of using a battery carried on the moving car for re-establishing contact between the well insulated conductor and the sectional conductor :—

"For this reason we prefer for railways on the ground, not to replace our automatic mechanical contact-makers by electrical contact-makers operated by the mere short circuiting action of the wheels or brushes on a train, but, instead, a current . . . to use accumulators, or a battery, or a small magneto or dynamo machine on the train to operate the contact-maker, or lastly, to arrange that the short circuiting of two things at any contact-box can only put current on to a section if the current has already been supplied to the previous section—that is to say, although the successive short-circuiting action produced by the train at each contact-box will, in succession, connect the next section with the main supply cable, and disconnect the last section, the short-circuiting of certain things at any one contact-box at random will produce no effect whatever." And, as a further proof of the striking similarity between our devices of 1883 and Mr. Wynne's of 1890, we may quote the following, which occurs in the same specification, after the account of the detailed methods adopted for working the contacts by the battery carried on the train boxes :—

"It is to be observed that, although a train which has been at rest in any section, can, by one application of the battery it carries, cause, at will, the main supply cable to become connected with that section, and, as it proceeds along it can, without any further application of this battery, connect the supply cable with every section in succession, disconnecting it in succession from each section left, no mere random short-circuiting of the end and beginning of the rails of any two sections, or of the insulated and earth rail of any one section, by means of a crowbar, for example, can produce any effect at all."

In the report on Mr. Wynne's system stress is laid on the fact that by connecting two adjacent sections in parallel with the rubbed conductor, so that the circuit through one section and the motor on the train is closed before the circuit through the section behind is broken, Mr. Wynne obtains an arrangement which "effectually

obviates sparking." I have again merely to quote the following from our patent 783, of 1881 :—

"When a carriage or train in the ordinary course passes from one section to the next, whether going forwards or backing, the main current, as already explained, is put on to the section the carriage or train is entering before it is taken off from the section the carriage or train is leaving ; indeed, it is not until the carriage or train has received the current on the section just entered that it is taken off from the section being left ; and for a short time, while the carriage or train is partly on one section and partly on the other, it is receiving current from both sections, and we have adopted this arrangement partly in order that the induced sparks or flashes that are usually produced in making or breaking an electric circuit, and which rapidly burn away the contacts, shall not be produced by our form of contact makers."

No one admires the go-aheadness of the Americans more than I do ; but when an idea of pure British origin returns across the Atlantic with so strong a Yankee accent that it might well pass for having been born and bred in the States, one feels that that is going ahead just a little too fast.

The following letter referring to this matter has also been sent to us for publication :—

I should like to make a few remarks on the note in your last issue referring to my system of applying electricity to the working of urban tramways.

From your note, it might be supposed that having worked out a scheme on paper, I at once rushed into print ; this, however, is very far from being the case, as, with your permission, I will proceed to show, and also to show that my claim to novelty is fairly well founded.

The first patent dealing with the subject of sectional conductors is Mr. Ayrton's, 783, 1881, in which he applies them to electric railways for the expressed purpose of reducing leakage of the current, and he employs a sectional insulated rail, made slightly elastic, and furnished with mechanical plungers, through which, by the effect of the weight of the passing train, contact is made to the main insulated conductor.

Dr. Hopkinson, in his patent 4,718, 1882, refers also to the use of insulated sectional conductors on electric railways, for the same purpose of preventing leakage, and he employs the rise of potential caused by the car running on to a new section to make the connection from the main conductors to these rubbed insulated sectional conductors.

My first patent for applying electricity to tramways is dated 9th April, 1883, nearly seven years ago ; in this the special advantages of using short-rubbed road bars on electric tramways, as opposed to fenced electric railways, is for the first time fully described, and the principle of using such short lengths of uninsulated rubbed road bars, charged successively, so short that the ordinary traffic of the street is secured by the protection of the cars from accidental introduction into the electrical circuit, is for the first time developed ; and at the same time details are given of an automatic electric system whereby these short lengths may be successively charged from an insulated conductor.

Prof. Ayrton followed with his patent, 2,395, 1883, for conductors for electric railways (a continuation of part of his patent, 783, 1881). In this he effects the successive charging of his insulated section ("a mile or more in length") by causing a momentary short circuit as the train enters a new length.

In my patent, No. 9,215, 1886, for electric tramways I provide for an even greater sub-division of the rubbed road contacts than in my earlier patent, and amongst other matters show a contact-maker actuated by an electro-magnet carried by the car.

Messrs. Pollack and Binswanger, in the electric tramways patent, 14,106, 1886, adopt my principle of making the rubbed road contacts short and protect the ordinary street traffic from contact with the charged sections ; they effect the successive connections with a main insulated conductor by means of an electro-magnet carried by the car, which acts by induction on contact-makers in the roadway.

In my patent, 747, 1887, more than three years ago, I show another way of charging successively these short protected lengths, and in this system there is no limit to the power available for making these contacts good.

For all the above inventions patents have been granted both in the United States and in Germany, which may be taken as a fairly satisfactory proof of novelty.

My patent of 1886 was followed by long and complete trials on a full gauge line, at Messrs. Elwell-Parker's works, but nothing was published, as they resulted at the time in only partial success, though in a great deal of hard experience.

Before submitting the system described in your last issue to the notice of the engineers of the Brush Electrical Engineering Company I had profited by the criticisms of some of the best known tramway engineers whose advice I had the advantage of obtaining.

I wish it to be clearly understood that I do not make any criticism, favourable or unfavourable, on other systems, but may mention that it was with a full knowledge of what I had done, and of what had been done by others, that the engineers of the Brush Company expressed the opinion "*That it is the only practical attempt that, up to the present, has been made to grapple with the real difficulties of urban electric traction.*"

FRANK WYNNE.

AN APPLICATION OF ELECTRICITY TO CHEMICAL RESEARCH.

THE alloys are usually and somewhat vaguely defined as the peculiar compounds or mixtures which different metals are able to form with one another. Probably as much variation is exhibited in the behaviour of metals in forming alloys as exists amongst their own chemical and physical properties.

Many of the metals can be alloyed together in all proportions, *e.g.*, silver and lead ; others, however, like lead and zinc, will only alloy to a limited extent, thus zinc only absorbs 1·2 per cent. of lead, and lead only 1·7 per cent. of zinc. Frequently, also, certain non-metallic elements as sulphur and phosphorous occur in substances which are generally classed as alloys ; as an example, the so-called "phosphor bronze" may be instanced.

Alloys generally conduct both heat and electricity sufficiently well, though there are certain exceptions ; in the case of electricity their conductivity is proportional to the relative volumes of the metallic constituents of the alloys.

The question arises, Are these alloys of definite chemical composition, or are they mere mixtures unaffected by chemical affinity ? Most of the data which have been acquired by varied observations and experiments seem to indicate that alloys are in most cases definite compounds. Thus, if an alloy were a mere mixture it would seem reasonable to suppose that the density number would be approximately equivalent to the mean density of the metallic constituents, but observation tends to show that the density of an alloy is very frequently different from this mean value. A similar observation holds with regard to the melting point of alloys.

Again, during the formation of the alloys, a con-

siderable rise of temperature is often noticed which seems to indicate that chemical union has taken place amongst the metallic components, for the evolution of heat is a well-known phenomenon accompanying chemical combination. For example, when one of the alkaline metals is added to some mercury, or when tin is alloyed with gold, a certain amount of thermal disturbance is noticed which seems to suggest the exercise of some chemical affinity; it must be confessed, however, that the rise of temperature is difficult to determine, and more difficult to measure. On the other hand, it is assumed, whenever a substance crystallises in a definite form, that it is a chemical compound of definite composition; but although many alloys undoubtedly do possess a distinct form, it has been shown by Cooke (*vide* "Proceedings of the American Academy of Arts and Sciences." New Series. Vol. V., p. 337) that alloys of zinc and antimony of very variable composition all crystallise in the same way. Storer has also showed that the same crystalline form must be assigned to all the alloys of copper and zinc, in whatever proportion these metals be used. It is quite plain, therefore, that the evidence of crystalline form cannot always be relied upon as proving the existence of a definite chemical substance.

But when all the observed facts are reviewed, it seems exceedingly probable that most of the metals are capable of existing in combination with each other in definite proportions. The great difficulty experienced in isolating one of these compounds is due to the fact that they dissolve in all proportions in the melted metals which are used to form them, and the alloys very rarely crystallise out. Another difficulty which is met with is that whereas the distinctive feature of a chemical compound is the alteration of the physical characteristics of the constituents in the alloys of the metals, this alteration is not so markedly apparent, thus compare the extent of alteration in the union of hydrogen and oxygen to form water, and in the case of copper and zinc, to form brass.

The Proceedings of the Royal Society contain (*vide* Vol. XI., p. 430) an interesting paper by Matthiessen and von Bose, in which they divided and classified the metals into two groups :—

Group A = zinc, tin, lead and cadmium.
Group B = most of the metals.

The metals in the first of these groups impart to the alloys that are made from them their own physical properties, according to the proportion in which, as constituents, they exist in these alloys; while the metals in group B, which comprises most of the known metals, do not impart their properties to their alloys in this way. Thus, whilst most of the metals may form alloys, which are probably substances of definite chemical composition, it is extremely probable that the metals of group A do not, hence that the alloys of lead, tin, cadmium and zinc are mere mixtures of the component metals.

In order to demonstrate the truth of the hypothesis, so far as it concerns group A, Mr. A. P. Laurie has recently brought an exceedingly interesting method of research to bear upon it. His own account of his investigations may be consulted in detail in the printed transactions of the Chemical Society (Vol. LV., p. 677).

If the alloys of the metals in group A are merely mixtures, then, it was argued, on examining their behaviour in a voltaic cell, in which a plate of alloy is substituted for the zinc plate of the cell, an electrometer ought to detect the more positive metal, even when the quantity of this metal present is very small.

The alloys of lead and tin were first submitted to experiment in this way: they were cast in thin plates in an iron mould, and were composed of standard assay lead and pure grain tin. One of these plates formed one element of the voltaic cell, a lead plate coated with chloride of lead formed the other, and the exciting liquid was a slightly acid solution of stannous chloride. In the case of lead and tin the difference in potential is small, so ten cells were joined up in series.

The following E.M.Fs. were recorded :—

	Volt.
Pure tin	0·035
Alloy (1 per cent. lead)	0·015
„ (10 „ „)	0·020
„ (50 „ „)	0·015
„ (70 „ „)	0·015

Thus the addition of 1 per cent. of lead to the metal modified the E.M.F., whence the introduction of more lead had no appreciable effect, hence, as Mr. Laurie points out, there is no evidence, as far as the electrometer can show, of the existence of a compound between the lead and the tin.

It occurred to this chemist to study the distribution of the constituent metals in a block of alloy that had been slowly cooled; analyses were made of samples taken from different parts of the block, with the result that a general tendency was apparent for the tin to be thrown to the outside of the block. Only one alloy of lead and tin appeared to be at all homogeneous—namely, that which contained 21 per cent. of tin.

This is corroborative evidence, for if the alloy be a definite compound, then, when blocks of it are slowly cooled, analyses made from any part ought to reveal precisely the same chemical constitution.

In connection with the investigation, so far as it concerns lead and tin, it may be observed that in a recent paper by Spring, published in the "Bulletin de l'Académie Royale de Belgium," série [3], T. XI., p. 86, the author states his belief that chemical union does not take place between these metals.

As already observed, the metals lead and zinc absorb but very little of each other in forming an alloy. It is stated by Matthiessen and von Bose in their paper (*vide* Proceedings of the Royal Society, Vol. XI., p. 430) that zinc can only retain 1·2 per cent. of lead, and that lead can retain only 1·7 per cent. of zinc. These alloys were now investigated by Mr. Laurie in the same way as before.

The cells contained a plate of the alloy, a plate of lead coated with lead chloride and a solution of zinc chloride. The reading of the electrometer showed :—

	Volt.
Pure zinc	0·496
Alloy (1 per cent. zinc)	0·483

Then the presence of so small a quantity of zinc was fairly indicated by the instrument. Mr. Laurie believes that the lead, as it were, tries to reject every trace of zinc, and that the little it contains is probably mechanically caught in the metal while cooling.

Similar experiments were next undertaken with alloys of zinc and tin; the voltaic cell contained, as before, a plate of amalgam, and in this case a plate of tin, zinc chloride, and stannous chloride. It was found necessary, however, to amalgamate the zinc alloy, in order to obtain regular readings. The electrometer recorded the following E.M.Fs. :—

	Volt.
Pure zinc	0·536
Alloy (1 per cent. zinc)	0·530

Alloys containing from 10 to 70 per cent. of zinc gave deflections which were in every case comparable; and the inference that the metals do not combine is certainly justifiable.

Finally, the following alloys were tested by the same method :—

x alloy of lead and 3 per cent. cadmium.
y „ „ tin „ 3 „ „

These alloys yielded results which again support the theory; the E.M.Fs. recorded by the electrometer were :—

	Volt.
Pure cadmium	0·322
Alloy *x*	0·264
Alloy *y*	0·292

The detection of these small quantities of the more positive metal, cadmium, implies that cadmium does not combine with either lead or tin.

The whole investigation sufficiently confirms the theory of Matthiessen and von Bose, that lead, zinc, tin, and cadmium do not form alloys which can be regarded as definite chemical compounds.

These physicists also stated that nearly all the metals form alloys, *without* imparting to them their own physical properties in the proportion in which they, themselves, are present in the alloy, hence it would seem that these alloys consist of definite chemical compounds.

In a former paper (*vide* "Transactions of the Chemical Society," Vol. LIII., p. 88) Mr. Laurie has described the behaviour of alloys of zinc and copper, also of copper and tin, in a voltaic cell; he succeeded in demonstrating that these metals possess sufficient chemical affinity to cause them to combine, and that the resulting compounds may be represented by the formulæ Cu_2, Sn, and Zn_2 Cu.

ELECTRIC OSCILLATIONS IN RAREFIED AIR, WITHOUT ELECTRODES.

A Demonstration of the Non-conductivity of a Vacuum.

By JAMES MOSER.

M. HERTZ has recently obtained an experimental realisation of the theories of Mr. Heaviside and Mr. Poynting respecting electric oscillations. According to these theories the electric oscillations in a wire originate upon the surface of the wire, and the slower they are the further do they penetrate into its interior. The more rapid the more superficial they remain. M. Hertz imagines a wire conductor in the form of a cylindrical cage. Twenty-four wires stretched between two metallic discs represented the surface of a cylindrical conductor, whilst in the middle a metallic rod joining the two centres of the discs, and interrupted by a spark micrometer, represented the axis. He showed that an electric oscillation induced in this did not produce any sparks in the micrometer placed upon the axis.

This led me to make the following experiment (*Comptes Rendus*), in which I use rarefied air spaces without any metal, and without an electrode of any kind as conductors for the oscillations.

It has often been observed that tubes of rarefied air become luminous in the neighbourhood of an induction coil in action. But, according to all accounts, the tubes were furnished with electrodes passing through the glass as in the Geissler tubes, or simply applied to the external surface, as in those of Gassiot. But in no description have I found the experiment which seems to suggest itself, and which consists in exciting a tube without any electrode by the discharges of a bobbin placed near it. Yet, the elimination of the electrodes would simplify the solution of some problems in physics.

In my experiment, I enclose a sealed tube of rarefied air, 40 centimetres long and 3 millimetres in diameter; in another tube, which is somewhat longer, and is 10 millimetres in diameter. This outer tube is sealed up at one end, and fitted at the other to the Geissler pump. The vacuum of the inner tube remains invariable and becomes luminous, and of a light blue colour, without stratification, when near an induction coil. If, now, we also produce a vacuum in the outer tube, the vacuum of the inner tube remaining constant, we note the following facts:—

1. If, in the outer tube, the pressure is equal to that of the atmosphere, the inner tube, under the influence of a bobbin, becomes luminous, and turns light blue, as usual.

2. If, in the outer tube, the pressure is reduced to 1 millimetre of mercury, the air in it becomes conductive and luminous, and turns dark red. At this moment the *protective effect* of the enclosing tube shows itself. The phenomenon is reversed.

We know that the Geissler tubes, furnished with electrodes, and brought to a state of extreme rarefaction, will not conduct an electrical discharge. This phenomenon has given rise to a great deal of discussion. Some physicists have explained it by the insulating power of the vacuum; others, looking upon the vacuum as a good conductor, conclude that great resistance to the passage of the discharge is offered at the surface of the electrodes. But, in my experiments, there are no electrodes; thus there can be no question as to this resistance to the passage. The experiment shows, in fact, that by lowering the pressure to less than one millimetre and rendering the rarefaction extreme, the enclosing tube again becomes obscure and the inner tube luminous. In appearance it is the same as if the pressure in the outer tube were equal to that of the atmosphere.

The most perfect vacuum, therefore, has no longer any protective effect; it is devoid of conductivity for the electric current.

ON THE MAXIMUM OF THE GALVANIC POLARISATION OF PLATINUM ELECTRODES IN SULPHURIC ACID.

By C. FROMME.

IN this third memoir the author considers the influence of the size of the electrodes. Experiments on the galvanic polarisation of very small platinum electrodes in sulphuric acid have been communicated in the first memoir, and a series of important results have been arrived at. But they cannot be satisfactory in every respect because in the course of the experiments a small cathode becomes blackened, *i.e.*, platinised. For estimating the influence of this superficial change upon the polarisation, every starting point was at that time wanting.

This difficulty has been overcome by coating the cathodes, large or small, with a thick stratum of platinum black. Their magnitude is either 1 square centimetre (K *large*), possessing the form of a square plate, or a wire 0·3 centimetres in length and 0·025 centimetres in thickness (K *small*). Their superficies amounts to 0·015 square centimetre. The anode was always bright and was used first of both the same two sizes as the cathode (A large = 1 square centimetre, A small = 0·015 square centimetre). On repeating the experiments the surface of the (small) anode was reduced to 0·005 square centimetre.

The investigation leads to the following final conclusions:—The polarisation of a platinum sulphuric acid voltameter varies very rapidly with the size of the electrodes, increasing both as the size of the platinised cathode and of the bright anode.

The maximum value is apparently soon reached. With a large bright anode a high polarisation of 3·72 volts is reached if the cathode is taken very small and if the acid used is strongly diluted. It is to be remarked, that even after platinising the cathode, the polarisation still increases decidedly with the decreasing surface of the cathode. The polarisation depends least upon the concentration of the sulphuric acid when both the bright anode and the platinised cathode are large; the difference of the highest and smallest value amounts to 0·78 volts. If the anode is large and the cathode small the difference = 1·59 volts, and with a small anode and a large cathode = 1·39 volts, respectively 3·58 volts and with a small anode and a small cathode = 1·40, respectively 2·91 volts.

Between acid of 0 and 44 per cent the polarisation is highest at A small, + K small, and at A large, + K small, in 0·4 per cent. (p = 3·72 volts) both at A small, and K small, in 32 per cent. (p = 3·87 v.)

In acid of more than 44 per cent. the highest attainable value of 5·5 volts is reached at 47 per cent., at least if the anode is very small. The possible causes

of the great variability of polarisation with the surface of the electrodes and the degree of concentration have been already considered in the first memoir. That the polarisation must increase with the decreasing surface of the electrodes results also from the "Thermodynamics of Chemical Processes," by Von Helmholtz. For with the diminution of the surface more gas is liberated in each of its elements; hence the proportion of the gas of the adjacent strata of liquid must increase. Hence, according to theory the polarisation must increase. On the other hand its increase with the density of the current and with its concentration is occasioned by the accumulation of secondary products, especially at the the anode.—*Annalen der Physik und Chemie.*

MORGAN'S AUTOMATIC ELECTRIC POLICE SIGNALLING SYSTEM.

Its "Raison de Conception," Description, and Utility.

By ERNEST DE VERE HILL.

PART I.

"*Raison de Conception.*"

DURING the past few years the public mind has been much exercised, and anxiety heightened, by the gradual accumulation of undetected crime throughout the country, and one is almost tempted to exclaim that our civilisation cannot yet be complete. Recent events, even within our own metropolis, have painfully forced such conviction upon us, for even here, in the very centre of civilisation, we are constantly astounded and shocked by the direst of horrible deeds and the most dissolute of criminal offences; yet we are surrounded by a protective machinery with which no other city in the world can compare. Even this, however, is very often found to be inadequate to cope with its enemy, not on account of any administrative deficiency or want of ardour on the part of its individual factors, but because each and every one is only human, and possessed of but the same capabilities and powers of locomotion as the fugitive. The telegraph plays an important part in the curriculum of the police and detective departments, and is invaluable in the rapid transmission of instructions and reports as between one police centre and another; but it very often occurs that an enormous advantage to the police efficiency would be the result if there existed some other and more handy means of communication than the ordinary telegraph office or police station telegraphs.

"Time waits for no man," and where desperation is a factor it is surprising how much can be done in a short space of time. Experience has shown that very often scents and clues are lost and fugitives escape simply because the readiest means of communication with superiors or the authorities, as the case may be, is some distance from the scene of action, consequently any improvement as regards acceleration, or increased facilities in the transmission of messages should always be welcome. It would be an unassailable advantage if there existed in every large centre of habitation a direct means of communication between the central police depôt and a point in every street it controlled throughout its district. This would necessarily mean direct communication between the police authorities and any individual policeman upon whatever beat within that particular area. It would save running away to the telegraph headquarters and give the police a mighty weapon of co-operation, especially during the night. It is constantly seen at what a great disadvantage a solitary policeman is when, upon his night patrol, he comes upon some difficult piece of investigation or intrigue. How thankful that man would be to be able to communicate with a brother officer or the central police station without springing a noisy rattle or blowing a whistle. It is easy to recognise what a boon any means of communicating direct and instantly with the central station would be to him, especially if that means be a hidden and secret one. Again, how materially the peace of the community at large might be affected for good if any means existed whereby every right minded citizen could be enrolled practically as a special constable, and as occasion required caused the police to be on the alert without the waste of even one precious moment, or further, a means that enabled householders themselves (without running hither and thither for a constable, or even without going outside their own doors) to acquaint the police of "fire," "burglary," "murder," or what not.

All this is the "raison de conception" of Morgan's (police) automatic electric signalling system, and it is the most complete system of its kind ever yet invented. Every conceivable advantage accruing to such a system of police signals seems to have been grasped by the inventor, and though, by involving many functions and several indicating instruments, it appears at first sight somewhat complicated, its apparent intricacies rapidly disappear on personal inspection and acquaintance. Its manipulation is within the powers of any person of common intelligence, and its signals are transmitted, not by a private code method, but in plain longhand wording, so that any ordinary policeman can be perfectly at ease when using it. By this system direct communication is established and maintained between police stations and constables on duty upon their beats and *vice versa* between constables and the police stations. This great point is secured by means of a number of street lamp-posts, suitably distributed, which have within their hollow stems an arrangement of proper mechanisms for sending and receiving signals and which are electrically connected by wire to a central station. Here, also, a suitable set of apparatus is provided for receiving and despatching silent but visible signals to any individual lamp-post. If the whole area to be supplied with this signalling system is too extended to ensure satisfactory working from one centre, or to cause an inconvenient collection of wires, it is intended that this area shall be divided up into sections. Each section shall have its own district central station, and these central stations shall be in direct communication with the headquarters.

PART II.

Description of the Apparatus.

The apparatus employed in this signalling system is divided into two main divisions. That necessary for the central station, and that required at the lamp-posts. These two main divisions are connected together by overhead or underground cable. Necessarily every individual lamp-post is practically a small self-contained central station, as far as the apparatus is concerned, because it contains the same instruments of exactly similar description as the central station; the only difference being that they are, by compulsion, much smaller in size and construction.

At the station is found the indispensable electric battery; secondly, the likewise necessary switchboard; then the signal receiver, the signal transmitter, the telephone, and the Morse recorder.

In the lamp-posts we find the receiver, the transmitter, the telephone, the constable's private number instrument, and the citizen's transmitter. The qualification as to apparatus *in connection* with these lamp-posts suggests that some portion of it is not attached to the lamp-post itself, but is located elsewhere, although necessary to the satisfactory working of the lamp-post signals. This is so, as the battery is located at the station, and two other portions away in another direction to be indicated later on.

Fig. 1 shows the office receiver for receiving the signals from the distant lamp-posts, any one on any constable's beat throughout the district. When a call

comes in from any policeman the electric gong within the receiver raises the alarm. At the same time the number of the particular lamp-post from which the policeman is signalling is put "en evidence" by the long pointer. This pointer being in direct electrical communication with the lamp-post revolves around the dial in the same direction as the hands of a clock, until it reaches the number corresponding to that of the lamp-post from which the call originated. It is intended that this receiver dial can be divided up into as many sections as there are lamp-posts in its circuit. In the engraving it is divided into 100 divisions, and is capable of controlling therefore 100 different sections of the surrounding inhabited district. Directly the long pointer has taken up its position at the number, the short pointer is actuated, and revolving in the same direction stops over the particular message or want despatched by the constable at the distant lamp-post. Here, again, it is necessary to notice that the dial is also divided into message sections, the number of which depends upon the construction of the instrument. In the woodcut it is divided into 24, and the message specified in those 24 sections respectively are "Citizen's call," "Report," "Telephone," "Send officer," "Wagon," "Send wagon and 4 men," "Hurry wagon and full company," "Ambulance," "Stretcher," "Large crowd," "Crowd threatens," "Riot," "Murder here," "Burglary here," "Message received," "Procession has started," "Procession has arrived," "Meeting has adjourned," "Fire," "Fire under control," "Yes," "No," "Detective wanted," "Test." Of course the wording of these messages can be varied to suit the authorities. The handle represented at the bottom of the cabinet is of very strong construction, because it has a multiplicity of things to rectify in one single revolution. Its duty is, in its passage of revolution, to engage the several portions of the interior mechanism and replace them in their necessary positions to receive another call.

Fig. 2 is the representation of the central station transmitter, the instrument for calling up and transmitting messsages to any distant lamp-post. When wishing to speak with a distant policeman it is necessary, first of all, to cause him to come to his lamp-post station, and, when there, to receive his message. The means of doing this is centred in the instrument in question, this central station transmitter. It is necessary to insert the plug at the end of the flexible communication of the transmitter into the numbered hole on the switchboard corresponding with the number of the lamp-post to which it is desired to send the message. The pointer on the dial is set at whatever message, thereon pointed, it is intended to transmit. The little crank on the lower box is moved forward to close the electrical circuit, and away travels the message. The effect of these combined operations is to be seen at the distant and indicated lamp-post. What this effect is will be shown presently when dealing with the lamp-post portion of the apparatus. Suffice it to say that it is ample to attract a constable's attention, and cause him to hurry to his lamp-post and receive the communication. As was the case with the receiver dial, this transmitting dial is divided into message sections, the number again depending upon the construction of the instrument, and the wording of such messages entirely depending on the discretion of the authorities.

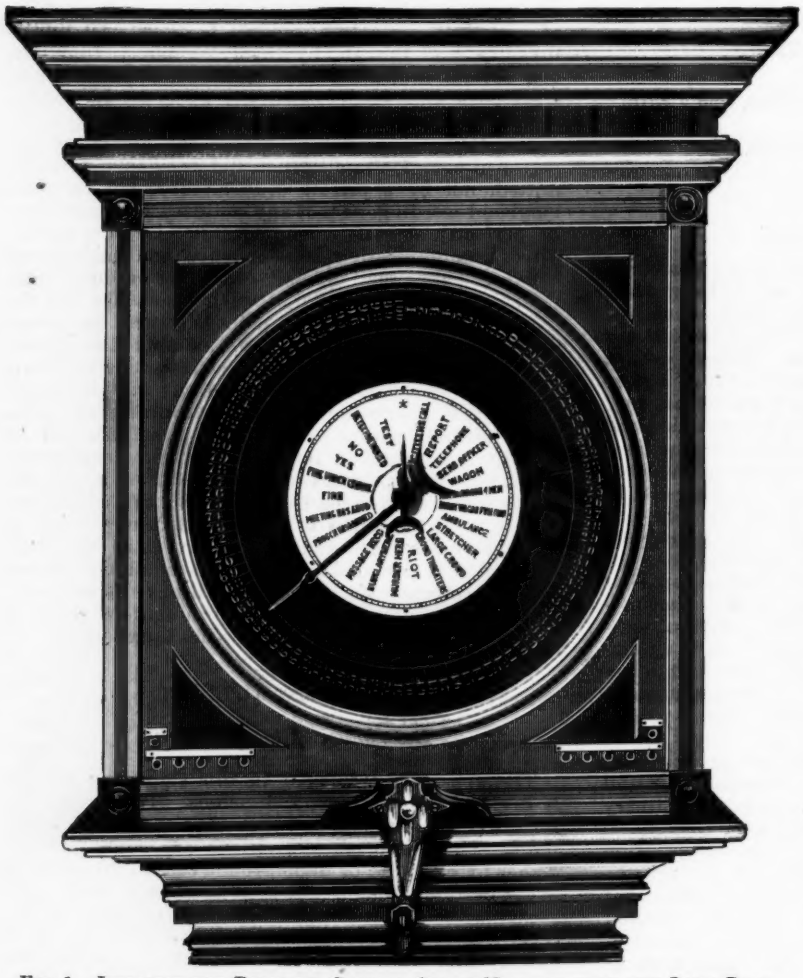


FIG. 1.—INDICATOR FOR RECEIVING CENTRAL OFFICE MESSAGES FROM THE LAMP POSTS.

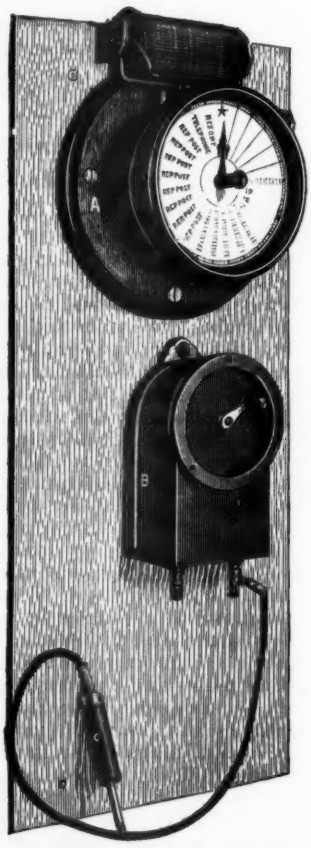


FIG. 2.—CENTRAL OFFICE APPARATUS FOR SIGNALLING AND COMMUNICATING WITH THE LAMP POSTS.

As here represented, 24 such sections are shown. They are not all filled up, however, but such messages as "Report," "Telephone," "Is crowd threatening?" "Has procession arrived?" "Has procession started?" "Has help arrived?" "Has relief arrived?" "Prisoner escaped," &c., are suggested, whilst several sections are devoted to the injunction "Report post," with a space beyond for insertion of a number. This last message is intended to be used when it is desired to concentrate quickly a force of police at any one particular point to suppress a riot or what not, and the number attached to it indicates the signal post within the riotous district. Any policeman knows, by reference if needs be, the locality in which this particular signal post is situated and immediately proceeds thither. A large force could, by this means, soon be secretly assembled.

FIG 3.—CENTRAL OFFICE TELEPHONE APPARATUS.

Fig. 3 shows the office telephone, which is nothing more or less than the ordinary commercial instrument, with the exception that it embodies the more sensitive arrangements that are applicable to it. If it is wished to hold a conversation with the distant constable the transmitter is operated as before explained. The pointer of the dial is set at telephone, and the closing of the circuit by the crank switch creates the alarm at the lamp-post; and the constable reads that he is registered on the telephone.

Fig. 4 is an adapted form of the ordinary Morse recording instrument used in telegraphy. Its duty is to register upon the travelling paper slip, in Morse characters, the private number of the constable who is at the moment communicating with the central office at the distant lamp-post, and sends it for the information of the superior officer with whom he is speaking. This information, it stands to reason, would be constantly required and requested by the central office, inasmuch as any and every police officer has access to any and every lamp-post apparatus. Inspectors and sergeants, for instance, who are not attached to any particular beat, might wish to make some important and hasty report to the central station. He is able to do so from any lamp-post, but whilst the central officials receives the number of the lamp-post and message correctly, they might wish to verify the report by attaching to it the reporter's personal number, and consequently signal "Report" or "Test." The constable is able to do this by means of a small portable instrument which he always carries in his pocket. Every officer is supplied with one of these, all identical in construction with one exception, and that is that the interior mechanism in each is arranged to roll out the owner's particular private number only. By the use

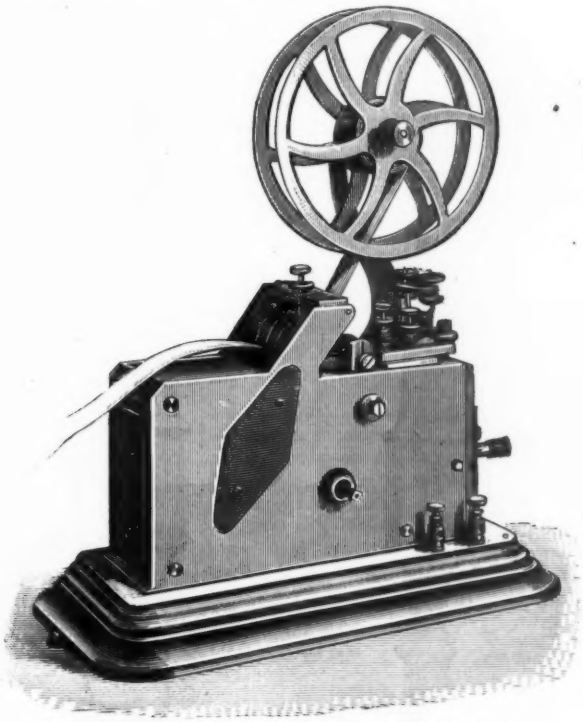


FIG. 4.—CENTRAL OFFICE APPARATUS FOR RECORDING POLICEMEN'S INDIVIDUAL NUMBER.

of this at the lamp-post, the Morse recorder slip is automatically started, and the constable's number registered thereon. When this is completed the paper slip stops; again by automatic means. All that remains now to make up the full complement of the central station apparatus is the electric battery and the switchboard. This electric battery is composed of Leclanché cells, each giving an electric current of half an ampère in quantity and a little over a volt in intensity. The number of cells employed depends, of course, upon the length of the circuit, and consequently upon its resistance. This Leclanché battery is essentially the central station battery, and exclusively used for outgoing signals to the lamp-posts. This must be specially remarked, as there is another battery of a different pattern also located within the station and used exclusively for the incoming signals.

The switchboard is necessarily pierced with as many metal sheathed holes as there are lamp-posts connected

with the central station. These holes are correspondingly numbered to the outside lamp-posts, and directly the plug is inserted in any one hole that particular line is open for communication. The exhibits at the central station being now exhausted, it is necessary to inspect the apparatus at the other end of the cable. "Cable" is stated, but cables would be a more correct term, as it is suggested to connect each lamp-post to the central station by a separate line. This appears, on first consideration, a detrimental point in the system, when the question of the multiplicity of wires already encircling all large cities, &c., is considered; but when the importance of the system for police and fire signals is realised, it can be easily seen that this separate wire arrangement is essential, in order to make it what it is intended to be, "absolutely non-interfering." At the other end of the cable is a lamp-post, not one of the ordinary street lamp-posts, because, to be always available, it was found necessary to have a lamp-post of a particular design for the purpose. These lamp-posts are to be erected at every spot throughout the district that will be convenient to the constables on duty, and form connecting links between beat and beat. The constables will, of course, have to be instructed always to keep within sight of either one or other of these signal lamp-posts, and to consider it as part of his duty to watch for any indication of alarm displayed therefrom. As the flash of a danger signal at these lamps plays an important part in this invention, the lantern in each has necessarily to be connected with the gas or electric supply mains; but as they are not intended for the ordinary street lighting, they must in no way be approachable to the ordinary gasman.

FIG 5.—LAMP POST.

FIG. 6.—SHOWING LAMP POST, WITH VISUAL SIGNAL RAISED.

Figs. 5 or 6 both represent these lamp-posts; but the latter has a small constructional advantage over the first. Fig. 5 is the lamp-post as it would be seen at any ordinary time, but fig. 6 represents it, as it were, "in action," that is, the appearance it assumes when the central station is wishing to speak with the constable upon the beat, or in fact any officer who happens to be within sight of the lamp-post at that particular moment. The transmitter at the central station having been put in circuit by means of the plug and switchboard, and the electric current reached the lamp-post, a portion of the mechanism in the interior has been operated, and has, in its turn, caused the cylinder of red glass to rise out of the circular holder below the lantern. At the same time the current has automatically ignited the gas or switched in an incandescent lamp. *This*, then, is the danger signal or alarm call before referred to, and is one of the effects mentioned when describing the mode of using the central station transmitter. The constable on duty is attracted by the red light (which by the way is as good a signal in the daytime, as at night, on account of its depth of colour) or he is made aware of its presence by a passing citizen and immediately hastens thither. His key which fits any lamp-post (and a fac-simile of which is in every officer's possession) admits him to his "box of tricks," that is, his receiving and signalling apparatus. *This* is situated and concealed within the largest portion of the hollow stem of the lamp-post. He can there read the message dispatched from the central station and reply, or not, as the case may be. Before closing the door he is particularly careful to extinguish the danger signal above. *This* he does by means of a vertical metal rod which lowers the red glass cylinder into its original position, and by so doing extinguishes the lighting agent.

The interior of the most bulky part of the lamp-post presents a miniature central station. When the constable's key has opened the door, fig. 7 illustrates what is there disclosed. The receiver and transmitter are above and below respectively on the right hand side, whilst the telephone occupies the left compartment. In the centre is the perpendicular metal shaft which controls the danger signal and lighting power in the lantern, and which is practically a counterbalanced lever. On the arrival of a signal from the central station, this perpendicular lever is automatically released, and being a little overbalanced with a downward preponderance the alarm is raised with a very gentle motion and without the slightest jarring of any kind. A finger hook attached, allows of its being drawn down by the constable before closing the door.

With reference to the lamp-post receiver, it will be easily understood that the message sections and their wordings upon the dial must necessarily correspond with and be the same as those upon the dial of the central station transmitter. This applies also to the lamp-post transmitter, which is a *fac simile* of the central station receiver. This instrument, however, differs from the station transmitter in its constructional phase. By reference, it will be seen that the central station transmitter is composed of two apparently distinct instruments, one arranged above the other, the dial above and the crank switch below. It is needless to point out that their separation is only apparent, as one would be useless without the other. This must be noticed, however, as the difference that exists between the lamp-post transmttter and the central station transmitter, simply a constructional difference, the end and aims being identical. The lamp-post transmitter is all in one bulk, and the separated crank switch portion of the station instrument is replaced by a metal bridge and hasp arranged across the face of the dial. This metal hasp is intended to be opened when sending a signal, so that the pointer

beneath it can be set at the message to be transmitted. The closing of the hasp completes the electrical circuit. This has a twofold effect; 1st, the flight of the message, and 2nd, the return of the pointer to zero. This automatic return of the pointer to zero is a good test arrangement, as it shows the perfect state of the line, and indicates to the policeman that his message has been received at the headquarters.

The method of using the telephone is precisely the same as at the central station and need not be further explained.

On the right-hand side of fig. 7, in front of, and a little above the receiver, is placed the device for dispatching the policeman's private number. It is simply a plug switch hole, the opposite halves of which are cut out of two pieces of metal, faced together, but insulated from one another by a strip of ebonite. By this means these two pieces of metal form the free ends of an open circuit, and if electrically connected would convey any signal to the central station.

With the exception of the disc arrangement fastened on the inside of the door, the whole of the interior mechanism has now been explained. It will be necessary to revert to this disc arrangement later on, so it shall be passed over for the moment.

The portions of the apparatus connected with this lamp-post signalling, but not included within it, are three in number. Firstly, we have the electric battery, and, as stated before, this is situated at the central station, but is entirely independent of, and of a different pattern to, the central station signal dispatching battery. That battery, it will be remembered, was composed of Leclanché elements. The one in question is an ordinary Gravity battery of the same power as the Leclanché. The necessity for using two batteries (which, although both located at the central station, are practically and electrically one at either end of the circuit) is in order to be able to signal in either direction over one wire, and to do this the circuit must be closed at both ends. For this purpose some form of closed circuit battery must be used, as a continuously closed circuit would soon polarise any form of open circuit battery.

The second detached portion is the policeman's private number instrument. It is portable, a little larger, but of much the same shape as an ordinary watch, and is intended to be carried in the constable's pocket. The works in the interior are constructed in each particular instrument to roll out one specific number, which number corresponds with that upon the policeman's collar. Upon the edge is arranged a projection about ½ an inch in length. It is essentially a split metal peg, the two halves of which are separated by an insulating material. It is intended to be inserted in the metal plug switch hole within the lamp-post described before. If the policeman wishes to send in his number, he winds the works inside by moving the small handle across its face. He now inserts the peg within the hole. This insertion closes the electrical circuit, the effect of which is to start the paper-rolling mechanism of the Morse recorder at the central station. The policeman now moves over a small switch arrangement, also provided on the edge of the instrument, and this releases the internal wheels, &c., which are arranged to transmit the Morse characters of his private number. These characters are imprinted upon the moving paper slip, and can be read by the officer in charge at the station.

The next unattached portion of the apparatus is nothing more or less than the lamp-post transmitter described before. It is, however, in its capacity as an unattached portion, that it will become more familiar to the public at large, and the outside world as distinct from the police force, than it would as the shut-up lamp-post transmitter. Its dial (with its message sections and pointer) has been explained, together with the use of its metal hasp; how it completed the electrical circuit when shut down, and how the pointer after it had dismissed the message returned automatically to zero. In its unattached use it is called the House or Citizen transmitter, and it is suggested that the police authorities, for the purpose of creating a revenue to the Government, might lease out these instruments to householders who would feel a security in being in constant touch with the police. For instance, could anyone undervalue a means by which he could, in the middle of the night, communicate with the police and concentrate their attention upon his house without even getting out of bed. The use of this instrument as a house transmitter, will carry out this very useful purpose. Let one of them be attached to the wall at the head of one's bedstead, and let it be connected with the central station. When occasion arises that the householder, finding himself in danger, would like to call up the police, he simply (without getting out of bed) turns the pointer to "burglary here," or what not, and closes the hasp. The ticking of the pointer, as it passes each message section on its way automatically back to zero, tells him that his message has been received at the police headquarters, and may be assured that the policeman on the beat outside is already probably on the scent. No noise made by him need apprise the maurauders of the near approach of their captors. He can quietly turn round and go to sleep again.

With the exception of the disc arrangement, which was pointed out as fixed upon the inside of the lamp-post door, the whole of the apparatus employed in this system has been now described. This disc arrangement can hardly be called an instrument, although it plays such an important part in the usefulness of this system that it must not be overlooked. It will readily be seen how necessary it is that only police officers or persons so authorised should have access to the instruments within the lamp-post, and it certainly must be ensured that whatever signals are sent to the central police station be *bonâ fide* communications. This is ensured at the signal lamp-post by the fact that only police officers are supplied with an "open sesame," or the key which opens the door, it being entirely entrusted to them. It must be carefully noted that this is the key which opens the door, because there is a distinction to be made which involves the aforegoing disc arrangement. Genuine calls on the part of the renters of the householder transmitter are secured by the forfeiture of all rights and claims to the use of the instrument by the defaulter until he can guarantee better behaviour in the future. Now it is to be expected that outside the circle of renters of the household transmitter there will be a number of good citizens to whom the boon of securing this immediate police protection would be acceptable, and yet this particular class of people have not the pecuniary status in life to enable to instal their own private transmitter. It is suggested that the police provide all such persons (if they are householders or renters of property) with what should be known as the citizen's key, to be kept and guarded by them individually, but which shall be at the service of the public in case of a genuine requisition for its use. There are many occasions upon which it would be advantageous to the common welfare that a policeman should be instantly called, or even the headquarters communicated with by a citizen, in a case, for instance, where the constable on the beat has met with some fatal mishap or more help is wanted. Yet it would not do to allow such persons to have access to the instruments within the lamp-post. The bestowal of the citizen's key is to effect this purpose, but remember it will *not* open the door; in fact it will not go anywhere near the keyhole intended for the official use. No, the citizen's key is made to fit into a keyhole communicating with the disc arrangement fixed on the inside of the lamp-post door. If a citizen or passer-by finds himself suddenly the witness of an outbreak of fire, of robbery, or a serious threatening of a disturbance of the peace, and, at the same time, remembers that his citizen's key is in his pocket, he is in possession of the means of alarming the nearest constable and the central police depôt without a moment's waste of time. He goes to the nearest signal lamp-post and inserts his key in the citizen's keyhole. The mere turning of the key, with the idea of unlocking the

door, automatically dispatches a signal to the district police station, and the officials there answer this call by immediately sending an electric current to the lamp-post. The effect is that the red danger signal in the lantern above is raised and the gas or electric light is automatically lighted. This exhibition attracts the attention of a constable whose duty it is to ascertain its cause, with the result that help or protection is instantly afforded. The citizen, however, has found it impossible to withdraw his key from the lamp post door; and this fact is an illustration of the insurance attached to the bestowal of the citizen's key against malicious practical jokers. The key when once inserted cannot be withdrawn until the whole machinery is in motion that can render assistance or secure the offender in the case of a false alarm. The policeman, having arrived, opens the door with his own key and sends his report to the central station. He, now, by raising a small catch upon the disc arrangement releases the citizen's key and returns it to the owner.

With this, the description of the whole of the apparatus in this system is complete.

PART 3.

Its Utility.

This system is like "a song without words." It needs no explanation of its working parts to determine its utility. A mere acquaintance with it, gained by a single personal inspection when in operation, is sufficient to demonstrate its work. Its capabilities are apparent, and there is no gainsaying its usefulness when applied to a thickly inhabited district. Its adoption in this City of London, for instance, would very soon prove its value, as it would have a considerable deterrent effect upon the criminal classes, whilst it would, most certainly, treble the effective force of the police, and therefore render unnecessary the further increase in the present force, which the existing condition of things seems to warrant.

It would be perfectly safe to assume that the establishment of say a thousand of these signal lamp-posts in the Metropolis would be equal to an increase of 3,000 policemen at least, or one post as an alternative for three men. This undoubtedly is the minimum estimate of its substitutive powers. Taking the yearly cost of a policeman at £75, the Government, having acquired all proprietary rights, would thus save £225,000 per annum, less, of course, the cost of maintenance, which, however, would be so exceedingly small that it could be practically disregarded. In ten years this would mean a saving of two millions and a quarter of public money.

This is only in London, and there are many other districts throughout the kingdom where the ratepayers could be similarly relieved. The adoption of some such system of signals would be a boon to the police and public as it would engender confidence and a sense of security. It also provides a means whereby the police headquarters may have complete surveillance and control at all times over each and every policeman. With these considerations in view, its adoption in every large centre of habitation should be accepted as an absolute necessity.

Lastly, after its installation, the system is not an object of continued outlay, for it affords a source of revenue to its proprietors, who should undoubtedly be the Government or its nominee in local government.

These signals may be adapted and applied to railway stations, hotels, institutions, factories, warehouses, &c.

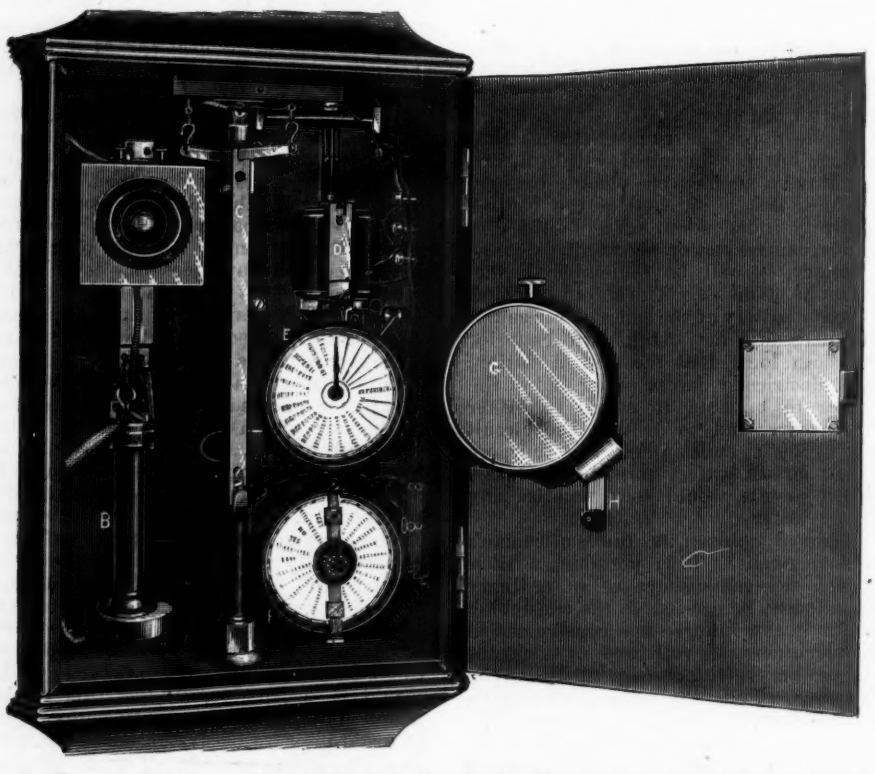


FIG. 7.—SHOWING INTERIOR OF LAMP POST, WITH TELEPHONE, TRANSMITTING AND RECEIVING APPARATUS.

Fog and Atmospheric Electricity.—In a letter to *Industries*, Mr. W. H. Daniels asks the question which, he says, has long been mooted in maritime circles, whether fog does or does not affect the mariner's compass. His own opinion is that it does for the following, to him, conclusive reasons: "Magnetism is a form of electricity and so is lightning; lightning is in the clouds, and a fog is a cloud. Moreover, in the normal course of things, a cloud should rise in the air, whereas a fog descends." The late Captain Saxby used to mention that on one occasion a convoy of thirty sail found themselves steering a wrong course through fog.

NOTES.

Electric Lighting Progress.—There are 161 applications for electric lighting provisional orders as against 17 in the previous session, and the capital which it is intended to be raised for electric lighting purposes is £9,242,828, or an advance of £8,244,828 upon the sum proposed for this purpose last year.

Lighting the East End.—At a recent meeting of the Aldgate Ward Ratepayers Association, members were told by the secretary not to expect the completion of the electric lighting of the eastern part of the City for another year, as a great deal of plant would be required.

The Board of Trade and Electric Light.—In the House, on Wednesday, Sir M. Hicks-Beach, in reply to Mr. Causton, said no such determination had been arrived at by the Board of Trade as was suggested by the hon. member—namely, without inquiry into the circumstances of the case, not to proceed with any applications for provisional orders to supply electricity if the local authorities refused their consent.

Electric Lighting at Brighton.—The proceedings at the meeting of the Brighton Town Council, which was held on Monday for the purpose of considering the proposals of the Lighting and Works Committees with regard to electric lighting, were of a somewhat animated description. At the outset numerously-signed petitions from residents were presented, objecting to the Corporation undertaking to supply the electric light, on the ground that the scheme would only benefit a very small portion of the town. It was eventually decided to apply to the Local Government Board for permission to borrow the necessary funds. Mr. Shoolbred, C.E., was appointed electrical engineer to the undertaking, and the Town Clerk was instructed to advertise for tenders for carrying out the work.

Electric Lighting at Bath.—Not long since Major Cardew, Board of Trade Inspector, paid a visit to Bath with the view of examining the electric lighting works now in progress, and expressed his entire satisfaction that the system was being carried out by Mr. Massingham upon the best known principles. In his opinion, when completed, there would be absolutely no risk of injury to persons in the streets, or to gas or water mains under the streets. He also thought it desirable that the authorities should obtain the opinion of some eminent electrical engineer upon the whole works when completed.

Railway Station Lighting at Bradford.—The station completed by the Midland Railway Company is throughout lighted by electricity. The systems employed are the Thomson-Houston for the arc lights, and Holmes's Newcastle machines for the incandescent lighting.

Paris Lighting.—The municipal station of Halles, Paris, is authorised by the Council to charge for lighting by the lamp hour in the case of small installations. A Parisian contemporary thinks this will merely complicate matters uselessly, and that the contract system will be found preferable in practice.

Light for the New L.C.C. Chamber.—At Tuesday's meeting of the London County Council, the Council Chamber and Offices Committee reported themselves of opinion that it would be desirable to adopt the electric light for the new Council Chamber at Spring Gardens. They had been in communication with several electric lighting firms, and had obtained estimates of the cost of installation. The most favourable estimate, having regard to the amount of light to be afforded and other details, was that of Messrs. Strode and Co., the amount of the estimate being £208. They made a recommendation accordingly, which was adopted.

Electric Lighting in Greece.—The light has recently been making great strides, notably at Athens. By a recent law overhead lines are prohibited.

How Directors are Made.—Sir H. D. Gooch has been summoned by the trustees of the late Sir Daniel as to whether shares standing in the name of the present baronet were not the property of the father. Mr. Justice Kay said that the late Sir Daniel Gooch was a person of very great wealth, and interested in various companies. His eldest son lived near him, his father giving him a liberal allowance. It appeared from the evidence that Sir Daniel, being desirous to provide his son with some occupation, in 1873 bought 100 shares in the Brazilian Submarine Telegraph Company; in 1880 50 shares of £100 each in the Ruabon Coal Company; and in 1881 260 preference shares of £10 each and 250 ordinary shares of £10 each of the Globe Telegraph and Trust Company, in the name of his son, for the purpose of qualifying him as a director of the companies. The son received the dividends and handed them to his father. The certificates of the shares were in the possession of Sir Daniel, and on the envelope was written by Sir Daniel, "Shares standing in the name of H. D. Gooch belonging to me." In his lordship's opinion the plain purpose of Sir Daniel was to provide an occupation for his eldest son, and that the defendant, Sir H. D. Gooch, was trustee of the shares for his father's estate.

Personal.—Mr. Kenneth MacIver, of the National Telephone Company, Limited, has recently been appointed to an important position in the head office of the company in London; Mr. Chambers, from Leeds, has succeeded Mr. MacIver as manager of the Manchester district.

The Electric Lighting Company of Liverpool.—On Saturday a dinner party was held at the Adelphi Hotel by the *employés* of the Liverpool Electric Supply Company, Limited, to celebrate the opening of the company's new and extensive works at 15, Highfield Street, in this city. An excellent repast was served, at which nearly 100 members were seated in the ball-room, the chair being occupied by Mr. Alfred Clough, works manager. After dinner the chairman reviewed the rapid progress in the company's career for the past few years, and held out strong hopes of even greater success in the future. In concluding, he proposed the first toast of the evening, "The Directors of the Company," the managing directors, Messrs. Holmes and Vaudrey, being specially mentioned, and the toast was responded to with great enthusiasm. During the evening a capital programme of songs and humorous readings was gone through to the enjoyment of all present. At the close a cordial vote of thanks was passed to the chairman, and the National Anthem having been sung, the party dispersed.

A Chance for Lecturers.—"The Balloon Society of Great Britain."—The Council having determined to allot one evening a month to lectures and discussions on electrical science, persons desirous of reading papers or attending the meetings are requested to communicate with the Secretary, 26, Budge Row, Cannon Street, City.

City and Southwark Railway.—An experimental run was made on Wednesday. A party of 50 gentlemen travelled in two small saloon carriages through the tunnel underneath the Thames to the Elephant and Castle. Things did not go smoothly, and this was probably anticipated, for the technical Press did not receive invitations to be present. We have only the irresponsible utterances of the daily Press reporters to guide us (the *New York Herald* stating the total electrical power to be 450 volts); but a delay of an hour and half, which had not been arranged for, shows that something was faulty. Probably the promotors of this railway will explain why they feared expert inspection, and if the railway is not to be in operation for some months, what was the reason of the run?

Nikola Tesla.—The *Electrical World*, N.Y., contains a portrait and notice of one of the foremost electricians in the States. Mr. Tesla belongs to the Slav race; his native place was Smiljon, Lika, where his father, according to our contemporary, was an eloquent clergyman of the Greek Church. Mr. Tesla, it seems, was a "quick-witted" boy who varied the monotony of youth by getting imprisoned in a remote mountain chapel rarely visited for service, and on another occasion by "falling headlong into a huge kettle of boiling milk just drawn from the paternal herd"—not "cold drawn," apparently. Our contemporary does not say whether, like St. John, cast into a caldron of boiling oil, Mr. Tesla emerged from his involuntary bath unscathed. A third curious episode was "connected with his efforts to fly" with the aid of an old umbrella, which resulted in his being laid up for six weeks. Mr. Tesla's career as an electrician has been, though brief, a distinguished one. He is only 33 years of age; in person tall and spare with a clean-cut thin face. He is an omniverous reader, and possesses the faculty of languages which is peculiar to the native of Eastern Europe.

A Field for Both.—Speaking at the meeting of the Tottenham and Edmonton Gas Company recently, Mr. Corbet Woodall, C.E., of Westminster, stated that one of the things which had caused, of late years, some uneasiness in the minds of gas shareholders had been the electric light. He thought they had now had sufficient time to form a fair idea of what would be the effect of the electric light on gas property. There was no doubt that the electric light would command a large business, and make profits. He felt satisfied, having had the opportunity of judging, both on the continent and in America, that nowhere was there a larger development of electric lighting than in London at the present time; but although there was this considerable development, the gas supply went on increasing from year to year. This was considered by the shareholders present at the meeting to be a very gratifying statement, and it is equally encouraging to electric lighting companies.

Florence to be Lighted.—The Municipal Council of Florence have just approved, by a majority, of a contract, previously arranged with the Italian Edison General Electric Lighting Company, for the electric lighting of the principal streets in the centre of that city. It is believed that the installation will be completed in three months hence.

Electricity on Belgian Railways.—Tenders were recently invited by the Belgian Minister of Railways, Posts, and Telegraphs, for the erection of an electric light installation at the Namur railway stations. The regulations contained in the specification were very stringent, and, as yet, the contract has not been decided.

Prizes for Electrical Work.—The Industrial Society of Amiens has recently issued the list of subjects for which prizes will be given in this year's competition. Among the prizes are three relating to electricity. The first will be a gold medal for the best electric light installation put up in a manufacturing establishment, and which has been in operation for at least a year. The installation must be more economical than if gas were used, it being assumed that in the latter case the establishment would have from 300 to 350 gas jets, the gas being made by the manufactory itself. The second medal will be given for the best application of electricity to the chemical industry in the district of Amiens; whilst the third gold medal will be awarded to the author of the best essay on physics. The choice of subjects is left open. The essays will remain the property of the Society, and are to be sent in unsigned by the 30th April next to the President of the Societé Industrielle d'Amiens, together with a sealed envelope containing the name and address of the author.

Appointment.—Mr. William John Hancock, M. Inst. E.E., Assoc. M. Inst. C.E., Superintendent of Telephones in the Railways Department, has been appointed to be Superintendent of Telegraphs and Telephones in the Postal and Telegraph Department, Western Australia.

Obituary.—W. H. Snell.—We have great regret in announcing that Mr. W. H. Snell, who has during the past two years edited the *Electrician*, died on Wednesday night. He had been ailing for some months, and was unable to attend to his journalistic duties, but it was hoped that a complete rest would have restored him to health again. To his friends and those associated with him in the conduct of our contempory we offer our sincere sympathy.

Removal.—For the greater convenience of shipping companies, merchants, and other customers in the City, the United Asbestos Company, Limited, have removed from 161, Queen Victoria Street, to the premises recently occupied by the East and West India Dock Company, viz., Dock House, Billiter Street, E.C., close to Fenchurch Street and other stations.

Idle Rumour.—A Netherland's correspondent, writing under date of February 26th, asks us if there is any truth in the rumour which has reached him that the Deptford station was to be closed, owing to the dangers which had attended the employment of high tension currents in America. We have heard nothing to lead us to anticipate such an end to the stupendous labours of Mr. Ferranti, on the contrary much activity seems to be shown in laying down the mains, so it is hardly necessary to say that our correspondent must have been misinformed.

The Brighton Lighting Scheme.—Mr. Crompton has been requested to report to the Lighting Committee of the Brighton Town Council concerning the proposed scheme for electrically lighting the Borough. He was asked for advice on—1. The best system of generating and distributing the electric current in Brighton; 2. The sites or site most convenient for generating centres; 3. The cost of plant; 4. Working cost; 5. On the use of the Corporation ash yard as a site for a central station with the object in view of utilising a portion of the town refuse as fuel; and 6. The comparative advantages of steam and gas engines for working the generating plant. His report may be seen in our other columns, and it is significant to note that it coincides very closely with the estimate of Mr. Shoolbred, Messrs. Killingworth Hedges and Ince to the contrary notwithstanding. The percentage he allows, after an extended experience, for the depreciation on accumulators, ought to convince these gentlemen on this point.

Ealing Electric Lighting.—We understand that the Maxim-Weston Electric Company have decided not to proceed further with their application to Parliament for a provisional order during the present Session. The company sought to acquire powers to erect and maintain an electric lighting station at Ealing, and to supply with electricity the district comprising the Broadway, the Mall, part of the Uxbridge Road, part of High Street and Haven Green, as far as the Metropolitan Railway Station.

The Telephone and Parliamentary Debates.—An interesting use was made of the telephone on Friday night. Mr. Gladstone and a party, including several well-known members of the House of Commons, were dining in Stratton Street at the house of a gentleman who has a private telephone communication with one of the Whip's rooms at the House of Commons. Through this medium the exciting course of events in the House as they developed was made known to the party in Stratton Street.

Electric Launches.—It is stated that Messrs. T. B. Seath & Co., Rutherglen, have secured an order for four electric launches from Messrs. Morton and Williamson, Glasgow, acting, it is understood, on behalf of the Electric Traction Company in London, who will themselves supply the electrical apparatus for propelling the launches. They are intended for service on the Seine.

About Rubber.—The "shortage" in the rubber crop of Brazil is said to be about 1,000 tons, and it is owing to this that the price has increased. Considerable speculation has been going on in this commodity. The present season ends with this month, and the next begins in July.

The St. Pancras Lighting.—At the weekly meeting on Wednesday last, the recommendation of the lighting committee, that £10,000 be given for a site for a central station in Stanhope Street was adopted, and the necessary permission was granted to borrow the said sum from the County Council.

American Progress.—As an indication of how time is utilised in America, we have just received a letter from a correspondent, dictated and typed on board the train named the Pennyslvania, Limited. This train is provided with every comfort, including such luxuries as ladies' maids, stenographers, &c.

A Loss in Telegraphs.—The revenue of the Post Office telegraphs is returned at £2,129,000, the expenditure being £88,604 above the receipts.

Telegraphists' Grievances.—Government telegraphists are combining to bring their grievances before Parliament and the public, having failed in their attempts to obtain redress from the official quarter.

Fires Caused by Electric Wires.—According to Reuter's New York agency, two more serious fires have been caused by electric wires. One occurred at a brewery at Elizabeth, New Jersey, the damage being estimated at 25,000 dollars. The other broke out in a dwelling house at Schenectady, New York, and the owner was suffocated on returning to his burning home in the hope of saving some of his property.

Electric Boats on the Thames.—By next June it is expected that there will be twenty-three or twenty-four electrically-propelled launches upon the Thames. Many house-boats are being fitted with the electric light.

Morgan's Electric Signalling System.—The system described in our columns may be seen, by appointment, in working order, at the Westminster Palace Hotel; further information may be obtained at the office of the Syndicate Company, 76, Finsbury Pavement.

Recent Interruptions and Repairs to Submarine Cables and Land Lines to February 25th, 1890:—

Between.	Interrupted.	Repaired.
Cable.—Punta Rassa-Cay West	18th Jan., 1890	24th Jan., 1890.
„ Fanoe-Calais	6th „ „	8th Feb. „
„ Chorillos-Mollendo ...	21st Feb., „	24th „ „
Landline.—Moulmein-Bangkok	4th „ „	5th „ „
„ Saigon-Bangkok ...	21st „ „	Still interrupted

The Institution of Electrical Engineers.—On Thursday, March 13th, 1890, there will be taken the adjourned discussion on the following papers: "The Theory of Armature Re-actions in Dynamos and Motors," by James Swinburne, member, and "Some Points in Dynamo and Motor Design," by W. B. Esson, member.

An Alteration in the Prepayment of Telegrams.—In the future, when a sender of a telegram has paid for the transmission of a reply thereto, and a pass delivered to the addressee enabling him to send a telegram, if such pass be not used, the postal authorities will, on receipt of same, refund the sum prepaid.

Electric Light Installations in France.—From a table which is published in the *Annales Télégraphiques* we gather that on the 31st December, 1888, there existed in France 151 installations for electric lighting and the transmission of power directly under the supervision of the Administration. These installations comprise all those in which the electromotive force exceeds 60 volts for alternating currents, and 500 volts for continuous currents. A very large number of installations are in operation and many of these are not mentioned in the table referred to, such as those located in private establishments, manufactories, railway stations, &c., since the electromotive force employed does not reach the limit at which Government inspection is required. We notice that among the various forms of mechanical power made use of, turbines number 49, water wheels 7 and gas engines 7. The installations quoted are in general on the two-wire system, and it is stated that the maximum quantity of current per square millimetre of conductor is from two to three ampères. The towns which possess more than one installation under Government supervision are Paris with eight, Marseilles and Bordeaux with three each, while Thury-Harcourt, Toulouse, Rives, Nancy, Verdun, Roubaix, Dunkerque, Clermont-Ferraud, Le Mans, Rouen and St. Germain-lès-Corbeil, have two each. At the works of Le Creusot there are three installations.

Electricity and Ships' Compasses.—Lieut. W. H. Schultze, superintendent of compasses of the U.S. Navy, has been investigating the question of the effect of lighting by electricity on ships' compasses. The deflections produced on compass needles by the dynamos are, he finds, very decided, in some cases as much as 2°. He recommends that the position of the dynamos should be a condition secondary to that of the compasses. In determining this question the induction of magnetism in bulkheads and other vertical as well as horizontal steel and iron must not be overlooked.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Laing Electric Light and Power Company, Limited.—The annual return of this company, made up to the 20th ult., was filed on the 23rd ult. The nominal capital is £1,000,000 in £10 shares. 12,007 shares are taken up, and of these 12,000 are considered as fully paid. Upon the remaining seven shares the full amount has been called and paid.

Eclipse Electric Lighting Syndicate, Limited.—The annual return of this company, made up to the 7th March, 1889, was filed on the 27th February, 1890. The nominal capital is £20,000 in £1 shares. 12,127 shares are taken up, 10,007 being considered fully paid. Upon 2,120 shares the full amount has been called and paid.

The return for the present year, made up to the 19th February, was filed on the 27th ult. At the date of the return 14,857 shares had been taken, 10,527 of these being considered fully paid. Upon 4,330 shares the full amount has been called and paid.

John Wild & Co., Limited (Mechanical and Electrical Engineers).—The statutory return of this company, made up to the 3rd ult., was filed on the 27th ult. The nominal capital is £10,000 in £5 shares. 850 shares are taken up. Upon 160 shares the full amount has been called, and there has been £2 per share called upon the remaining 690 shares. The calls paid amount to £2,180.

At an extraordinary meeting of the company held at registered office, Falcon Street, Oldham, on the 20th January, a resolution was passed adopting special articles of association in lieu of Table A of the Companies Act, 1862. This resolution was confirmed on the

10th ult. and was duly filed on the 22nd. Under these articles the number of directors is not to be less than three nor more than five, qualification 20 shares; the first are John Wild, of Chadderton; J. H. Foster, of Oldham, and J. S. Hulton, of Greenfield, near Oldham; remuneration as ordinary directors £20 per annum. Mr. John Wild is appointed managing director.

CITY NOTES, REPORTS, MEETINGS, &c.

Telegraph Construction and Maintenance Company, Limited.

THE twenty-sixth ordinary general meeting of the shareholders was held at the company's offices, 38, Old Broad Street, London, E.C., on Tuesday last, Sir George Elliott, Bart., M.P., in the chair, to receive the report of the directors (published in the last issue of the ELECTRICAL REVIEW) and accounts.

The Secretary having read the notice convening the meeting, also the minutes of the ordinary general meeting of February 6th, 1889, which were thereupon signed, and the report having been accepted as read,

The Chairman said: This being his first appearance as chairman of the company, he thought it incumbent upon him to make a few remarks. Having briefly alluded to the loss sustained by the company in the death of Sir Daniel Gooch, under whose administration the company had enjoyed an unbroken period of prosperity for so many years, he passed to a short explanation of the reasons which had induced him, the speaker, to comply with the unanimous request of his colleagues to accept the office of chairman. As some of his hearers were aware, he had been a director of the company ever since its formation—some 26 years since, after having been for ten years previously an active partner in the business, that was to say, before it became the company's property. It would be affectation, therefore, on his part to deny that he possessed as clear a knowledge of all its workings as any individual could well have. He had only to add that he took as keen an interest in its prosperity as he did when it was partly—he might say chiefly—his own property; and the shareholders might be confident that no effort would be wanting on his part to secure its continuous success. That success had, in his opinion, hitherto been due in no small measure to the policy adopted by the board from the first, that was to say, while giving the shareholders every information which they could reasonably desire, it had always maintained a wise reticence in regard to business matters, the publication of which might injuriously affect the company's interests. The shareholders had hitherto accepted that policy, and had placed that confidence in their directors, without which they could never have achieved this success. He trusted that in the interests of them all that course might still, in a great measure, be followed; of course there had been other causes to which the company's prosperity was due, and he would be wanting in fairness to the executive and permanent staff of the company if he omitted to say that that prosperity was very largely attributable to the energy, ability, and industry always exhibited by them. His predecessor had had perfect confidence in the arrangements of the executive officers of the company, and the speaker could truly say that he entirely shared that feeling. He was very glad to say that some of the most active of those officers had been officers under him before the company was formed. As regards the work carried out in the past year—which the shareholders would have judged by the report—they had not much to complain of. Their profits had largely been due to improvements in their general business other than the mere submarine telegraph. It was very satisfactory to know that they had something else besides the submarine telegraph upon which they could rely. As regards the future, so far as they were able to judge at this early period of the year, the prospects were favourable. They had two contracts in hand, one of which was already commenced, viz., the cable between Australia and New Zealand; while the other, the renewal of a portion of the Madras-Penang cable, would be taken in hand in the following week. Work was always arising. It had always appeared as if there was no great future for the company, but they had never failed to find the demands upon them of a nature to keep them fully employed, or nearly so. They had an excellent staff of agents and an admirable managing director, and a staff of men who were really the pith, so to speak, of their business; who made their cables and laid them; and he thought so far as that portion of their business was concerned they stood far, far away unrivalled by any other company. He now begged to move the adoption of the directors' report and accounts for the year ending the 31st December, 1889, and the payment of a dividend of 36s. per share (in addition to the 12s. interest and dividend paid the 30th June, 1889), upon all shares of the company for the past year, such dividends to be paid free of income tax.

The motion was seconded by Mr. Campbell and accepted *nem con.*

The Chairman then moved the re-election of Sir Thomas Fairbairn, Bart., and Mr. James Pender as directors of the company.

The resolution was seconded by Admiral Sir Geo. H. Richards and carried unanimously.

Mr. Croft then moved the re-election of Mr. John Gane at the same remuneration as last year, and of Mr. James Clegg, as auditors of the company.

The motion was seconded by Mr. McKay and carried unanimously; and with a vote of thanks to the chairman and board of directors the meeting came to a close.

The Westminster Electric Supply Corporation, Limited.

AT an extraordinary general meeting of the company held at the registered office, No. 4, Victoria Mansions, Westminster, on Wednesday, the 5th day of March, 1890, at 12 o'clock noon, Lord Suffield presiding, no reporters were admitted, but it was understood that the following resolution was proposed:—

That the articles of association be altered in the following manner:—

(*a*) In Article 7, after the words, "purchase of," the words, "or lent upon the security of," be inserted.

(*b*) In Article 18, after the words, "all the shares," the words, "not fully paid," be inserted.

(*c*) In Article 33, the words, "such form as the directors shall from time to time approve," be struck out, and in lieu thereof, the words, "the usual form of transfer," be inserted.

(*d*) In Article 36, after the word, "Shares," the words, "whether fully paid up or not," be struck out.

(*e*) In Article 85, the words, "and shall have paid to the company, in cash, £10 for the expense of giving notice as provided by the next following article. Any surplus of the £10 over the expense shall be returned after the meeting," be struck out.

It was also understood that the resolution, if passed by the requisite majority, would be submitted for confirmation, as a special resolution, to a second extraordinary meeting, which will be subsequently held.

The Brush Electrical Engineering Company, Limited.

THE following circular has been issued to the shareholders:—

"Six months having elapsed on the 10th February since the registration of the Brush Electrical Engineering Company, Limited, the directors have pleasure in stating that practically the reconstruction has been completed, and that the business of the company is established on a satisfactory and permanent basis.

"The total amount of orders received by the company is very satisfactory, and the prospects for the future are highly encouraging. The works of the company in London, at Loughborough, and on the Continent are fully occupied, and the extensions of the Falcon Works at Loughborough are making rapid progress towards completion.

"The directors have decided, in view of the satisfactory volume of business transacted during the past six months, to pay a dividend on the preference shares, and warrants for an interim dividend on these shares at the rate of six per cent. per annum, from the 10th August, 1889 (the date of registration of the company), to the 10th February, 1890, are issued herewith.

"The books of the company will not be made up until the close of the year, and the directors reserve the question of a dividend on the ordinary shares until the complete accounts are before them.

"By order of the Board,

"E. GARCKE, *Manager and Secretary.*"

1*st March*, 1890.

The Direct United States Cable Company, Limited.—

The Direct United States Cable Company, Limited, notify that they have opened to the public at 40, Hope Street, Glasgow, a new station for the acceptance, transmission and delivery of American telegrams. This station will be found most conveniently situated for American cablers.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending February 28th, 1890, amounted to £5,025.

The Cuba Submarine Telegraph Company, Limited. The estimated traffic receipts for the month of February were £3,300 as compared with £3,304 in the corresponding month of last year. The receipts for the month of November, estimated at £3,000, realised £3,112.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of February were £2,225, against £2,008 in the corresponding period of last year.

The Eastern Telegraph Company, Limited. The receipts for the month of February 1890, amounted to £53,347 against £54,611 in the corresponding month of last year.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for the month of February 1890, amounted to £38,466, as against £37,584 in the corresponding month of 1889.

The Great Northern Telegraph Company, Limited. The receipts in February, 1890, £19,300; 1st January—28th February, 1890, £39,000; corresponding months, 1889, £42,000; corrresponding months, 1888, £41,800.

West India and Panama Telegraph Company, Limited. The estimated traffic receipts for the half month ended the 15th February are £3,038, as compared with £2,703 in the corresponding period of 1889. The November receipts, estimated at £5,800, realised £5,989.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 28th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,558.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month of February, 1890, were £4,500.

LEGAL.

Callender v. Grant.—This case came on for hearing last week before Mr. Justice Chitty in the Chancery Division High Court of Justice. The plaintiff and defendant both carry on business in the City of London, not very far from each other, and the plaintiff sought an injunction against the defendant, restraining him from parting with an alleged agreement or guarantee, and from proceeding in an action in America by which he sought to enforce the alleged guarantee. The motion was made in the action, which was brought for delivery up of the alleged guarantee to be cancelled. Last year the defendant went to the States as agent for the plaintiff, who with certain other persons was interested in the Callender Insulating and Waterproofing Company. He took with him an authority from the plaintiff empowering John M'Lagan Grant to receive moneys from the company or the liquidator thereof, and he was to be paid 10 per cent. cash on all sums recovered by him. The defendant went to the States on August 24th, and returned on September 30th, 1889, and when he got back there were matters in dispute between him and the plaintiff. He then made a claim against the plaintiff in respect of certain shares and debentures of the company which he alleged he was induced to take by the representation of the plaintiff. On December 4th, the defendant's solicitor wrote to the plaintiff on the subject, for an action was threatened. Plaintiff's solicitor offered to accept service, but an action was not instituted. On February 14th the plaintiff received by post from New York a document which purported to be a summons of complaint for the present plaintiff to appear in an action in the States Court of King's County, New Jersey, to answer a claim for $15,000, with interest at 6 per cent. on the guarantee. He now moved for his injunction on the ground that the proceedings were vexatious, and that if the defendant felt aggrieved, as both parties were British subjects and in business in London, he should have brought his action here. Mr. Justice Chitty considered that the proceedings in America were vexatious, and he granted the injunction restraining them, and also restraining the advertisements, which were calculated to do harm to the plaintiff, who had business relations in America, ordering the defendant not to part with the alleged document, and to pay the costs of the motion now.

United Telephone Company v. Theiler.—This was a motion for judgment in default of pleadings in an action brought to restrain infringement of the plaintiffs' patents, which came up in the form of a short cause on Saturday last, before Mr. Justice Chitty, in the Chancery Division of the High Court of Justice.

Mr. MICKLEM, on behalf of the company, said the particulars of breaches indicated what the plaintiff company complained of. Certain instruments were supplied by the defendant to the Secretary of State for War, but, the Secretary of State for War being protected by privilege, the company had only been able to proceed against the defendant. His friend, Mr. Daldy, appeared for the defendant, and consented to judgment in the usual form.

Mr. DALDY assented, and after some discussion,

His LORDSHIP gave judgment for the plaintiffs according to the minutes agreed upon, and ordered the usual inquiry as to damages.

ELECTRIC LIGHTING OF BRIGHTON.

MR. CROMPTON'S REPORT.

1. ON the best system of generating and distributing the electric current in Brighton.—As I understand that your Council have already decided that a system of distribution employing storage batteries should be adopted for Brighton, and that the electric pressure used should not be dangerous to life, on all of which points I thoroughly agree with your Council, it is unnecessary for me to discuss the merits of the alternating transformer system, or any other high pressure system. The system that we have been so long using in London, at Kensington, and elsewhere, and which has now been definitely adopted by several other of the most important of the London companies—viz., Westminster Company and Notting Hill Company, is practically the same in all essential points as that in use at Liverpool, Bradford, Berlin, as well as in the Edison Central Station in America. In the last cases, however, the accumulators are only now beginning to be used to the same extent that I have used them at Kensington; but in all cases a network of mains has been laid down in the streets, supplied by continuous currents of comparatively low pressure, which are generated by a number of dynamo machines arranged in parallel circuit, so that failure or stoppage of any one machine does not seriously affect the supply. At Kensington, and in the newer London stations, the batteries of accumulators are also kept in parallel circuit with the dynamos, so that even if the whole of the moving generating machinery should be accidentally stopped, the current is still supplied to the lamps.

Although I personally am convinced that storage in the form of accumulators is a necessity for any system of distribution of electricity for lighting purposes which will be satisfactory to the consumers, yet I do not blind myself to the fact that these accumulators are the most expensive part of the plant, both as regards their first cost and as regards their cost of after-maintenance. In fact the result of experience has shown that it is not prudent to provide a less sum than that equal to 12 per cent. on the original cost of the accumulators to meet the cost of annual repairs and renewals in order to keep these accumulators permanently in a satisfactory condition. Long experience, however, has shown us that on the rest of the generating plant a sum of 5 per cent. on the steam machinery and 3 per cent. on the dynamo machinery is sufficient. It is therefore imperative to reduce the money spent on accumulator plant as far as this is consistent with obtaining the objects required from it.

In considering the requirements of Brighton we must look forward to the probable demand for electric lighting in five years' time. The plant that is to be now laid down should be so designed that it can be easily enlarged as the demand increases, as little money as possible being wasted on the purchase and fixing plant which will have to be hereafter altered or removed as the demand increases.

Following out this idea, I think, without doubt, it will be best to fix on one or two sites which have been pointed out to me near the centre of the town, one at Black Lion Street and one to the north of Church Street, and at one of these sites to put down a certain amount of generating plant and accumulators, and from this central station lay down a system of mains which may be described as consisting of two long mains parallel to the sea, one laid from the western end of King's Road and along Junction Parade, and the other from the western end of Western Road to the east end of North Street. These would be connected by four mains running approximately north and south, the centre and principal one running along Church Street to Queen's Road and West Street, the western one through Montpelier Road from Western Road to King's Road. The eastern one down East Street to Junction Parade, and the remaining one connecting North Street with King's Road through Ship Street, Prince Albert Street, and Market Street. The approximate length of these mains appears to be about 5,100 yards, and I have estimated that the total cost of laying conductors in culverts throughout from end to end on the system I have successfully employed in London, and including the cost of making these culverts of sufficient size for all possible future requirements, but including only as much copper as will be required for your earlier demands, will be nine thousand five hundred pounds (£9,500).

2. Next as to the site or sites at which the electricity should be generated.—Bearing in mind that one object of your Council is to get to work on a moderate scale as quickly as possible, I think that for present purposes, as I have stated before, the choice of the available generating sites lies between that in Black Lion Street, which is already Corporation property, and the site which has been pointed out to me on the north of Church Street, and which is marked B on the plan attached. The choice of generating sites depends on: 1st, its position in regard to the district, *i.e.*, that it should be as centrally placed as possible; 2nd, that it should be so placed as to give a minimum of nuisance and annoyance to the neighbours. In this we may include the placing it so that fuel can be carted to it and ashes can be carted away with the least possible interruption of the traffic of the streets.

Now, although your site in Black Lion Street possesses a great advantage in its central position, and that your buildings could be commenced on it without further delay, yet it has been pointed out to me that a tall chimney shaft on this site would be an objection on account of its nearness to the Town Hall and other prominent buildings, and that if the chimney is made of moderate height there is danger of nuisance from the steam beating down to the windows of the adjoining houses. Further, this site is only just large enough for the purpose, and being bounded on the north side by private property which possesses ancient lights, the building on this side can only be carried to a very moderate height; and further, bearing in mind that the only two nuisances which can be caused by a central electric station are: 1. Communicating vibration to the neighbours, and 2, steam escaping to the chimney, I think, on the whole, that all these difficulties will be more completely avoided on the site B to the north of Church Street than site A in Black Lion Street. Site B appears to be free from all the above mentioned objections. It is fairly near to the railway station, so that the carting of coal to it will be only over a very short length of the streets. This site appears to have only one disadvantage, that it is not quite so central, and therefore the mains will cost somewhat more, but this sum has been allowed for in the estimate I have above given, and there is also some doubt whether your Corporation could obtain possession of it at an early date. If this last matter can be got over, I think when all the circumstances are weighed, this site is to be preferred.

3. On the Cost of the Plant.—I have attached an estimate of the plant costing £30,000 which is sufficient to supply electricity for 5,000 16 C.P. lamps lighted simultaneously. This estimate includes the item for mains above mentioned, it includes what I believe to be an ample sum for accumulators sufficient for your purpose; in fact, from my knowledge of the business, I can state there are many contractors who would be prepared to carry out the work in a thoroughly satisfactory and substantial manner for this figure. It is not easy to state with exactitude what number of lamps will be required to be attached to this system in order to reach a certain output per annum, *i.e.*, the sale of a certain

number of units per annum. Until this is determined it will be impossible for you to fix a price per unit or to estimate what will be your income from the sale of electric current, but as it is of the highest importance that your committee should be able to form an opinion on this point, I place at your disposal the following data which I have obtained from London experience. At Kensington we find that if the number of lights supplied to shops exceeds that supplied to private houses that a plant of the size I am now proposing for Brighton would be sufficient for only about 12,500 lamps attached to it; whereas if the proportion of lights supplied to private houses is considerably in excess of that supplied to the shops, then we may safely attach 15,000 lamps to the same plant, and with a proportionate increase of income. If we take the latter case, the income at the London rate of 8d. per unit would be £13,500 per annum, but at the proposed Brighton rate of 6d. it would be a trifle over £10,000 per annum.

4. On the cost of working the plant.—I attach a table showing the cost of producing electricity worked out from data obtained in London, and which shows there will be a sufficient margin of profit so soon as the number of lamps attached to the system reaches 7,500. I have given additional data to show how greatly the cost will be reduced as the quantity sold increases. The cost of electric energy, like that of gas or of many other commercial products, depends within very wide limits on the scale of production. Thus it will be seen that it is not until the proposed plant has sufficient lamps attached to enable it to work to an output of 400,000 units that the cost price can be reduced below 2·858 per unit. I should have no difficulty in showing you that if the plant was extended to an output of one million units per annum, the working cost could be reduced to 2d. per unit sold. In all these tables of working costs, the principal items for coal, oil, water, and labour are filled in from experience of actually working this system in London and elsewhere.

I must call your attention to my method of calculating repairs and renewals. This question has been recently very fully discussed by a committee of which Sir Frederick Bramwell was a member, and after considering the practice of gas and water companies, it was decided that the best method of dealing with the accounts of electric light companies as regards repairs and renewal fund is the following:—To set aside the following percentages on the value of various portions of the plant, and from the sum thus produced to deduct whatever is spent during the current year, and place the balance (if any) to a renewal fund. By this method sufficient money is provided to keep the plant in its original condition; that is to say, in perfect repair for any period. The percentages are as follows:—On the value of buildings, 2½ per cent.; dynamos, 3 per cent.; steam engines, boilers, steam pipes, switchboards, meters, and other machinery of the same class, 5 per cent. Accumulators, including racks or stands and connections, 14½ per cent. Mains, all concrete work, copper, glass insulators, ½ per cent. All ironwork and insulated cables, forming part of the main, 6 per cent.

5. The proposed use of the Corporation ash yard, site D, as an eventual generating site, having the object of utilising the town refuse as fuel.—No doubt, when you greatly extend your electric generating plant, this matter will then merit your more careful consideration, but as the laying of the main to connect it with the town will entail a considerable expenditure of capital, I do not think it need now be considered. When the question does arise, no doubt it will be an economical one, depending on the balance of saving which you make by using your refuse as fuel after deducting from this saving the interest on the first cost and cost of maintenance of the charging main, which must be laid down from the site D to the centre of the town; but, in any case, it appears that the proper and economical course to pursue would be to commence by a series of experiments at your ash yard, to determine what is the calorific value of your town refuse as fuel. I think the experiments could be carried out very cheaply by your own engineers.

The boiler of your stone-breaking plant could be used on some day at which the stone-breaking plant is at rest, and the quantity of water which could be evaporated by burning a given weight of town refuse could be easily determined. If the results were sufficiently promising I have no doubt that many makers of patent furnaces and town refuse destructors would be willing to join with you in the expense of carrying out the extended experiments. If these experiments showed that the calorific value of the fuel was sufficiently high to save £1,000 a-year by its use, then it would amply justify you in fixing on site D as the main source of supply of electricity to the town, as I believe that the interest on cost and maintenance of the charging mains will not exceed £500 or £600 a-year, which would show a nett gain.

If, however, it is shown that there will be little or no saving from the use of the refuse as fuel, then it is for you to consider whether your Park Street depôt, marked C on the plan, would not be the best of all for such a central generating station. At that site you have plenty of space for a very large station. The supply of fuel would be comparatively easy matter, as a siding from the railway can be laid into the station at a small cost. The cost of charging mains from this site to the various distributing stations would not be more than one-half of that from the site D to the same distributing stations.

If you eventually supply the town from distant generating stations, whether placed at the ash yard or the Park Street depôt, you would then require three or four distributing stations, which would contain accumulators, and which need be small in extent, in fact, resembling the distributing station I showed to various members of your committee in Queen's Gate Mews, South Kensington. The space for such distributing stations could easily be found. The use of the generating machinery at the Church Street site should be gradually discontinued, part of the site could be sold and part of it retained as a distributing station. A portion of the Black Lion Street site could also be used as a distributing station, and two others would have to be chosen.

In order to satisfy myself that there is no engineering difficulty that stands in the way of supplying Brighton with electrical energy from either end of the sites C or D, I have made estimates and designs in sufficient detail for a large plant to supply electrical energy sufficient for 200,000 lights distributed over the best part of Brighton. The results are quite satisfactory, and if your committee wishes to have them, I shall be glad to complete them and lay them before you, but they are not necessary for your present purpose, which is that of determining the best plant to put down for your present requirements.

6. On the comparative advantages of steam and gas engines for working the generating plant.—In order to compare the two methods of obtaining power, I have prepared Tables 4, 5 and 6 in order that they may be put in comparison with the similar Tables 1, 2 and 3, which I have worked out for steam power. I have said once that the costs which I have given as regards gas are not as accurate as I could wish them to be on account of the short time at my disposal. But wherever I have had doubt about figures I have rather favoured the gas plant. I have taken considerable pains to find out accurately what would be the consumption of gas per unit with Crossley engines of the size that has been proposed by Alderman Hallett, and I find that his figure is probably a fair one, viz.: that a unit can be obtained with a Crossley's engine using Brighton gas at a cost of 1·62d. You will see from Table 5 that any slight differences in this, one way or the other, will not materially affect the result.

If you will compare Table 5 with Table 2 you will see that the advantage is greatly with steam. One cause for this is that when gas engines are used it is absolutely necessary to provide a much larger supply of accumulator storage than is the case with steam, and consequently the item for maintenance of accumulators is very high; in fact, nearly three times the amount of the corresponding item when steam is used. This fact alone is sufficient to account for a difference of a thousand a year in the cost of repairs and renewals. The saving we must credit to steam in the case of fuel and labour is not so marked, amounting to only about £300 a year in the case of the quarter output, and £1,200 a year in the case of the full output. I have thought it fair to make the general expenses the same in both cases. The general result shows that not only does a 3,000 kilowatt gas plant cost one-sixth more to put down than the corresponding steam plant, but that the steam plant can be worked as economically at a quarter output as the gas plant can at half output, and that when we come to full output the cost per unit is 2·58d. for steam, against 4·35d. for gas.

The floor space occupied will be nearly the same in both cases, and, as far as I can judge, the labour will be the same in both cases. I think I should here remark that it is by no means easy to make a large plant of gas engines perfectly free from being a nuisance to the neighbours. Any attempt to make the engines quite silent always results in a great loss of power, and further than this, it is very difficult so to deaden the shock of the explosions as to prevent them being communicated through the foundations or the pipes to the surrounding houses. I know that in many cases we ourselves have been successful in this respect with gas engines, but we could not hope to be always successful if we used them on a very large scale. There is no doubt that all other things being equal, it is much more difficult to deaden the vibration of a gas engine than that of a steam engine. However, there is nothing whatever to prevent your committee from putting down a portion of the generating plant at the proposed station in the form of a gas engine and dynamo, and it would be valuable and instructive to us to thus compare the cost.

In ending my report, I wish to bring strongly before you the point to which we engineers can lead you with absolute certainty. This point is that we can tell you the exact cost of putting down the plant and working it to any desired output, but we cannot tell you with certainty the extent to which the demand will arise in your town, and as your future profitable working depends so greatly on the extent of this, it is not easy for anyone to advise you what should be the price to fix per unit during your early stages. The figures I have put before you may lead you to suppose that the price of 6d. per unit, which has already been mentioned, would be a profitable one, but it is for the committee, who know their fellow townsmen, to form their own opinion as to the period which will elapse before the required rate of output is obtained.

Then follow several tabular statements. The first has relation to steam power, and is as follows:—

Cost of plant for 330 kilowatts, or 15,000 16-C.P. lamps.
Maximum number of lamps lighted simultaneously, 5,000

Buildings	£3,000
Generating plant—boiler, steam engines, steam-pipes, dynamos, switch-boards, &c.	10,500
Mains	9,500
Accumulators	4,000
Meters and house connections	3,000
Total	£30,000

Next comes a statement of the cost of working at various rates of output from quarter to full load. The calculations are too wide to come in these columns exactly as they appear, but the four rows of figures below are based on, first line, 3,750 lamps attached and 100,000 units sold; second, 7,500 lamps and 200,000 units; third, 11,250 lamps and 300,000 units; fourth, 15,000 lamps and 400,000 units.

Coal, oil, labour, &c.	Repairs and renewals.	General expenses.	Total.	Cost per unit in d.
£	£	£	£	£
825	900	500	2,225	5·35
1,450	1,000	600	3,050	3·675
2,000	1,275	800	4,075	3·25
2,325	1,375	1,000	4,700	2·85

If interest on £30,000 at the rate 4 per cent. be added, then the cost per unit will be increased as follows :—

Units sold.	Cost per unit in pence.
100,000	8·2
200,000	5·1
300,000	4·22
400,000	3·6

The following explains the method of calculating repairs and renewals :—

			£	s.	d.
Buildings	2½ per cent. on	3,000	75	0	0
Dynamos	3 „ on	2,855	86	0	0
Other plant	5 „ on	7,645	380	0	0
Mains	0½ „ on	8,500	42	10	0
Mains	6 „ on	1,000	60	0	0
Accumulators	14½ „ on	4,000	580	0	0
Meters, &c.	5 „ on	3,000	150	0	0
	Total		1,373	10	0

Estimates on Gas.

The following is a calculation based on the use of gas instead of steam :—

Cost of plant for 300 kilowatts or 15,000 16 C.P lamps.	
Maximum number of lamps lighted simultaneously	5,000
Buildings	£2,000
12 sets Crossley's nominal 21 H.P. engines, complete, with dynamos	10,600
Switchboards and instruments	1,000
Mains	9,500
Accumulators	10,500
Meters and house connections	3,000
Total	£36,600

And this is the estimated cost of working with gas, the four rows representing, as in the steam table, the variations between 3,750 and 15,000 lamps and 100,000 and 400,000 units sold :—

Gas.	Labour.	Oil.	Repairs, &c.			General expenses.	Total.			Cost per unit in d.
£	£	£	£	s.	d.	£	£	s.	d.	
675	420	100	1,600	0	0	500	3,295	0	0	7·9
1,350	665	180	1,540	0	0	600	4,535	0	0	5·4
2,025	750	280	2,170	0	0	800	6,025	0	0	5·0
2,700	830	320	2,377	10	0	1,000	7,227	10	0	4·35

Repairs and Renewals: Gas.

This is the method of calculating repairs and renewals :—

	£	s.	d.
Buildings	100	0	0
Engines and dynamos	440	0	0
Switchboards and instruments	60	0	0
Mains	102	10	0
Accumulators	1,525	0	0
Meters and house connections	150	0	0
Total	£2,337	10	0

Works Committee's Report.

The full text of the Works Committee's report is as follows :—The Works Committee are informed that the Lighting Committee are about to recommend the Council to purchase, as a site for an electric lighting station, certain land and buildings between Bread Street and Spring Gardens, and extending from Church Street to North Road, belonging to Messrs. Vallance, Catt & Co., of which only a portion will be required for the purposes of the Lighting Committee, and that the remainder will be available for re-sale, or to be retained for other Corporation purposes as the Council may determine. The Works Committee regard this as a favourable opportunity of obtaining the additional space which they have long required, near the centre of the Borough, as a stone yard for materials, and in which the water and other carts belonging to the Corporation may be placed under cover when not in use, and they are of opinion that the surplus land should be retained for those purposes. The Works Committee concur in the suggestion of the Lighting Committee that in the event of the Council adopting this course, £4,500 of the purchase money should be apportioned as the price of the portions of the property coloured red, green and brown on the plan submitted, which are not required for the electric lighting station. The part coloured green is let on lease to Messrs. Pollard for a term of which 12 years from the 24th June next are unexpired, at an annual rent of £80, and the Committee think that the part coloured red will be sufficient for their present purposes, and that it will be unnecessary to acquire Messrs. Pollard's interest, whose tenancy might therefore be continued, and thus reduce the annual cost of the stone yard by the amount of their rent. As the Corporation can now borrow money at 3¼ per cent., the annual charge upon the rates in respect of the portions of the property coloured red, green and brown on the plan would be as follows :—

Interest at 3¼ per cent. on £4,500	£146	5	0
Less Messrs. Pollard's rent	80	0	0
Leaving as the nett annual rent of stone yard	66	5	0
Add annual contribution to sinking fund to liquidate debt in 30 years	90	16	4
Total annual charge on the rates	£157	1	4

In conclusion, the Works Committee concur with the Lighting Committee in recommending that the property of Messrs. Vallance, Catt & Co. be purchased on the terms offered, and the Works Committee further recommend that the parts of the property not required for the electric lighting station be retained for the purpose of a store yard; that the purchase money be apportioned as suggested by the Lighting Committee, and that the Town Clerk be instructed to apply to the Local Government Board for sanction to borrow £4,500 on security of the general district rates for a period of 30 years in respect of such purchase.

Motions Relating to the Subject.

Councillor E. A. Dell will submit a motion practically to the effect that the supply of electricity by the Corporation be not proceeded with.

Councillor Ballard has given notice to move: "That this council do resolve itself into committee to consider the scheme of electric lighting proposed by the Lighting Committee, with powers of adjournments and to call in the aid of experts to attend such committee, the public and reporters not to be excluded from the meeting or meetings of such committee."

And Councillor Blaker has on the agenda: "That his worship the Mayor be requested to call a public meeting of the ratepayers of the borough, to consider the question of the corporation undertaking the lighting of portions of the town by electricity."

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

(*Continued from page* 246.)

4. Ratio of Armature Section to Field-Magnet Section.

In the early days of dynamo-designing the cross section of the armature core in cylinder machines was very small in proportion to that of the field magnets, the copper in the armature was excessive, and the air gap correspondingly great. The result was an induction no greater than in modern machines, but an enormous stray field. In the machines made by my firm six years ago, the section of the armature core was about one-third of the section of the magnets, the latter being of wrought iron. I may say these machines anticipated Mr. Swinburne's latest notions, inasmuch as the 14-inch armatures of those days were loaded to 25,000 ampère turns. The first great improvement consisted in doubling the iron and halving the copper, a machine so modified giving about the same output, but with less heating and less sparking, and requiring less magnetising force. We got the same output for two reasons: first, the decreased magnetic resistance resulted in an increased total induction; secondly, of this induction a far higher proportion was utilised. The ratio of the armature section to the magnet section, when modified as above, stood at ·66; but we went much beyond this in increasing the iron in the armature, finding that we obtained for every increase, keeping the air gap the same, an increase in the induction. The latter was not, of course, in proportion, but it was still very considerable, as will be realised from the fact that in an armature having a ratio of ·75 the induction was 10 per cent. greater than in one having ·6. When Mr. Kapp read his paper here on "Characteristics,"* I mentioned that then the ratio in our dynamos stood at ·75. Since then we have, in machines for incandescence lighting, returned to ·6, for a reason which will be by-and-by apparent. It

* Nov. 11th, 1886. See *Jour. Soc. Tel. Engrs.* vol. xv., p. 548.

may be mentioned here that when the magnets are of cast iron the ratio is ·33, while the cast iron yokes for wrought iron magnets are from two to two and a-half times the area of the wrought iron.

I bring this forward because it is of some importance when the aim is to construct dynamos having a large output for their weight. The weight of the armature is only a fraction of the total weight of the machine. The field magnets are many times heavier, but, besides these, the bed-plate, bearings, &c., make up a large portion of the weight; and since the weight of neither magnets nor bed-plate is increased by an increased armature section, manifestly, if a large output for the weight is the object, and if nothing occurred to interfere with the process, the cross section ought to be increased to such dimensions that for any further increase to the total weight of the machine we get no corresponding advantage.

Some interesting experiments to determine this point, which completely corroborate my own, were made by Mr. Dugald Jackson, of Cornell University, and communicated by him in 1887 to the American Institute of Electrical Engineers.* These experiments can be consulted by those interested; for the present my remarks are based on the results obtained. Assume that the iron core of a cylinder armature having a ratio of ·6 is one-tenth of the total weight of the machine: then, by increasing the ratio to ·75—that is, roughly, increasing the weight by 25 per cent.—we make an increase in the total weight of 2·5 per cent. But the increase in the induction will be about 10 per cent., so that clearly an advantage has been gained by increasing the section. If we increase the mass of the armature core by 50 per cent., it makes 5 per cent. increase in the total weight, but we get 15 per cent. increase in the induction. If we go farther we shall still get an increase, but it gets correspondingly less with each addition to the weight. The actual increase may not be in all cases in the proportion I have given. Necessarily it depends upon the design of the machine, but in the particular dynamo to which my remarks refer the results were as stated; and what I wish to point out is that in light-weight dynamos the armature must have a comparatively large section, and be worked at a lower saturation. Though the output for the armature weight is less, the output for the total weight is greater.

There is a limit to increasing the cross section of the armature, which is reached when self-induction troubles us by creating a tendency to sparking, and cross induction troubles us from the diminished saturation of the core. Accordingly the practical limit in this direction is fixed for us at about ·75, and the induction at 14,500 or 15,000 C.G.S. per square centimetre. It must not be forgotten that increasing the section of the core increases the length of the wire on it by a small percentage.

Pressing the induction up to high values is not advisable, as the magnetism then costs too much. It will be seen from the curve, fig. 1, that the magnetising force to produce an induction of 18,000 per square centimetre is about twice, while the magnetising force for 20,000 is more than six times that required for 17,000. As the core saturation is increased the stray field is increased,

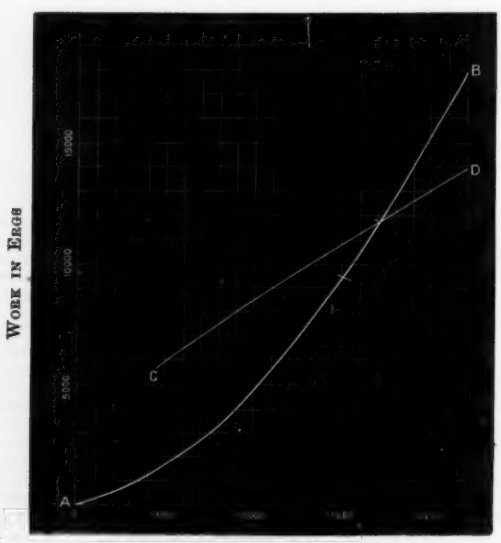
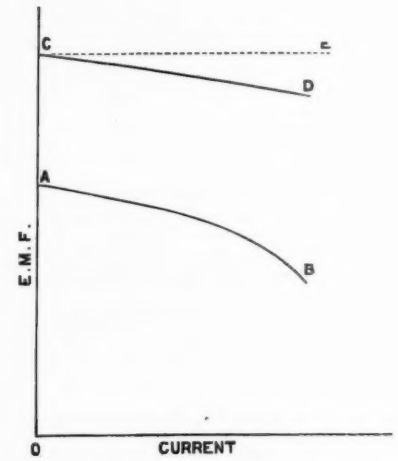


FIG. 14.

while the heating due to hysteresis is also greater. Everything considered, 17,000 per square centimetre is probably the best degree of saturation to employ for cylinder armatures, and makers who once employed a greater induction are, I believe, coming down to this. If we work lower we get on the bend of the curve, or on that part where the angle changes rapidly; so that it is not possible to obtain in compound machines, with a lower induction, such perfect regulation. It may be mentioned in passing that, since the loss of potential in the armature and series winding is generally in slow-speed machines a higher proportion of the E.M.F., in these the difference in the induction on open circuit and at full load is proportionally greater, and the compounding, in consequence, less perfect.

There is no particular advantage in reducing the induction, save that of obtaining a higher weight efficiency. The reduction of the loss due to hysteresis is very small, and less than might at first sight be imagined. In fig. 14 is given a curve, A, B, showing the energy in ergs required to carry a cubic centimetre of iron through a complete cycle of magnetisation at different degrees of saturation. Induction per square centimetre is measured by abscissæ, and the energy by ordinates. It will be observed that for 17,000 the energy is greater by about 24 per cent. than for 15,000; but for an armature of given output the cross section of the core has to be increased in proportion as the induction is diminished, and the total work expended in carrying the armature through a cycle of magnetisation is, roughly, proportional to the ordinates of the curve, C, D. To draw this curve an induction of 17,000 is taken as the normal, and all the ordinates of A, B, multiplied by the ratio of 17,000 to the induction. It will be observed that for any specified output there is only about 8 per cent. more power wasted in hysteresis at an induction of 17,000 than at 15,000.



C O, Strong field. A B, Weak field.

FIG. 15.

In four-pole machines it is usual to saturate the armature to a lower degree—about 14,000—and in alternators the induction is still less—about 6,000. As the curve, A, B, gives energy in ergs, the watts expended in the armature are found by multiplying this by the number of cycles per second and by the number of cubic centimetres in the armature, and dividing the product by 10^7. In drum machines the induction per square centimetre is rather over half of the value given for cylinders, and the ratio of armature to field section varies from ·8 to 1·0. The diameter of the armature being fixed with reference to the number and size of conductors, there is nothing to be gained by cutting away the interior of the washers. On the contrary, by cutting an opening only large enough for the shaft, the induction is kept low, and the magnetising force for the armature correspondingly small, while the heat generated due to hysteresis is also diminished.

5. INTERFERENCE OF THE ARMATURE FIELD.

Though iron may vary in quality, and so upset occasionally our calculations, no great difficulty need be experienced in approximating pretty closely the magnetising force required for a given induction in the armature core. But when we allow a current to flow in the coils, and so magnetise the core, we superpose on the original a second field and the interference between them readers the case no longer simple. If we excite the field magnets of a dynamo with a constant current, and allow currents of various magnitudes to flow through the armature, we find on maintaining the speed uniform that the E.M.F. falls as the current is increased. In 1884* some investigations of mine were published which dealt with this question, and established the result that when the ampère turns on the armature were few, and the field strong, the fall of E.M.F. with a fixed lead was about proportional to the current. As the field was weakened the line representing the E.M.F. began to bend, until, when it was very weak, a kind of inverse characteristic was obtained, as shown in fig. 15. In

* ELECTRICAL REVIEW, vol. XX., page 573, 1887.

* "The E.M.F. of Dynamo Machines excited by a Constant Current," ELECTRICAL REVIEW, vol. XIV., page 303, 1884.

fact, the results are similar to those which would be obtained by reducing the winding on the magnets; the effect due to this being small when the magnets are fairly saturated, and large when they are far from saturation. It was then observed that the Hefner von Alteneck winding produced least weakening effect on the field, while the now defunct Bürgin produced most, the Gramme taking a position between these two. Since that date electricians have talked frequently of the weakening effect on the magnets of the current flowing in the armature; but though it is admitted that the induction is the resultant of the magnetising forces both on magnets and armature, the conditions determining this resultant are by no means clearly comprehended.

Consider the magnetic system shown in fig. 16. N and S are

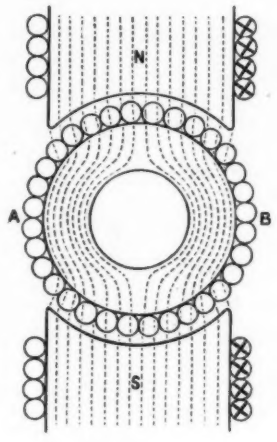


FIG. 16.

the north and south poles of a field magnet, the magnetising currents flowing into and out of the paper as shown by the open and crossed circles respectively. There is no current flowing in the armature coils, and the lines of force flow from pole to pole through the core as indicated by the dotted lines. Imagine that the current flowing round the magnet is stopped, and that a couple of brushes placed on the collector at S, N, fig. 17, cause a

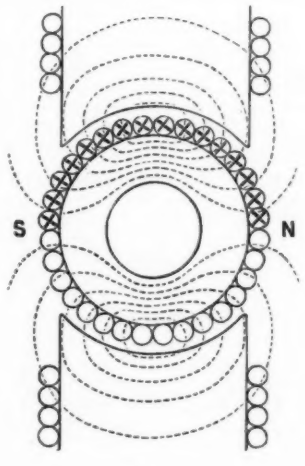


FIG. 17.

current to flow through the armature winding alone. We have the lines along paths indicated by the dotted lines, and obviously through this circuit, at right angles to the other, the cross induction depends, for a given number of ampère turns, mainly upon the length and cross section of the air gap. If we place the brushes at right angles to this position, we have no cross induction, but, instead, an induction taking the same path as the forward induction, though in an opposite direction. If the current is allowed to flow through field and armature coils at the same time, as it does in actual machines, we have the distribution of field as sketched in fig. 18, the lines of force due to the magnets being pushed towards the left-hand top corner and right-hand bottom corner of the poles. Where the armature or cross induction opposes the magnet, or forward induction, the field in the air gap is weakened; where the cross induction helps the forward induction the field is strengthened. In consequence of this distortion, with reference to the brushes, the sections under them have become active, and, to avoid sparking, a lead must be given, which will remove the commutated sections beyond the sphere of activity. This lead diminishes the forward induction, at the same time diminishing the distortion with reference to the new position of the brushes.

6. The Effect of Distortion on the E.M.F.

The distortion of the field produces in a dynamo run without lead a diminution in the E.M.F., for two reasons—first, because the induction acts differentially on the conductors lying between the brushes; secondly, because the currents flowing in sections active when short-circuited under the brushes weaken the field. These local currents induce lines in the opposite direction to the forward induction.

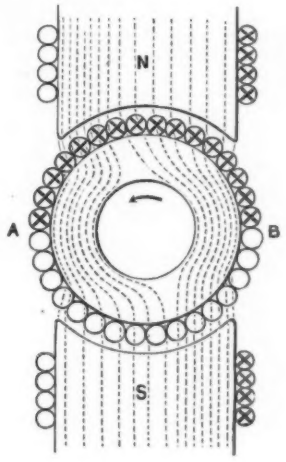


FIG 18.

Let the machine run as a motor in the opposite direction, the currents flowing through the field magnets and armature being of course in the same direction. The E.M.F. is induced in the armature in the opposite direction, and since in an active coil short-circuited under the brushes the current will flow in the direction of the induced E.M.F., its effect will be to directly strengthen the field as it increases the forward induction. We may say, then, that the effect of distortion is to diminish the E.M.F. in a dynamo run without lead, and increase it in a motor, owing to the local currents generated in the short-circuited coils.

The difference in the E.M.F. of a machine run without lead as dynamo and motor may be considerable, as shown by Prof. Ayrton's experiments at the beginning of last year.* These experiments were made on a drum machine which had a comparatively weak field. I am not quite certain as to whether the cause here given is sufficient to account for the difference, but I believe that were the brushes adjusted in each case until the local currents were annihilated, the same E.M.F. would be, with properly laminated armatures, generated by both dynamo and motor. That there is a certain amount of power wasted in these currents is quite obvious, though from their tendency to lessen the distortion in the motor, their magnitude, and the consequent waste, is in the motor less.

7. Position of the Brushes in Dynamos and Motors.

If dynamos are to run sparklessly there must be a lead given to the brushes, or, in other words, the point of collection must be advanced in the direction of motion until the field passing through the commutated sections is just of sufficient strength to stop the current, reverse it, and bring it to its normal strength in the opposite direction before the section leaves the brush. When a section is short-circuited under the brush, any lines of force which were induced, due to the current flowing in it, are annihilated, the current tending by self-induction to continue in the same direction round the short circuit. As the section leaves the brush a current has to be started in it in the opposite direction, and the self-induced E.M.F. opposes this also, thus tending to prevent both the stopping and the starting of the current.

The E.M.F. of self-induction depends, obviously, upon the variation in the number of lines through the section which the cessation of the current is capable of producing, on the speed of the armature, and on the number of turns per section. When an armature core is saturated to 17,000 per square centimetre it will be realised that the variation in the lines through the section which the short-circuiting is capable of producing is very small; in fact, we may say that it is practically negligible. But with the smallest amount of self-induction present it takes a certain time to effect these changes in the section, and the brush must be of such thickness that the changes are effected before the short circuit is removed. The brush must be placed in advance of the neutral point: in an armature, for instance, having 50 sections, presuming that five volts are wasted in the

* *The Electrician*, vol. xxii., p. 404, 1889.

armature, a section when it leaves the brush must move in a field having such strength as will neutralise the effect of self-induction, and give one-fifth of a volt over. If the armature has 100 sections, the field must give a resultant of one-tenth of a volt; but the E.M.F. due to self-induction will be in the latter case only one-fourth of what it was in the former. By saturating the core, and making the sections sufficiently numerous, we can make the self-induction as small as we please; and in machines in which the current varies from 0 to a maximum, we purposely make it as small as possible. The reason is that as the current increases, the variation in the E.M.F. of self-induction does not correspond with the variation in the shape of the field for different positions of the brushes, perfect adjustment for all currents being therefore difficult. By making the self-induction very small we get a close approximation to perfect adjustment; we can place the brushes very little in advance of the zero position, reducing in this way the adjustment for variation in the current to a minimum.

We see, then, that in a dynamo the brushes must be set in advance of the neutral point, and that self-induction increases the lead. Is the trail in a motor similarly increased? The answer is that it is. The brushes must be set in a motor behind the neutral position so that the induced E.M.F. is in the same direction as the current to be started in the section, and so that the E.M.F. of self-induction which opposes the starting is neutralised. It appears that the best position for the brushes in a motor is the position in which they have about the same trail as they have lead when the machine works as a dynamo and that in a motor the trail is *increased* by self-induction. In a dynamo the sections are short circuited after they pass the neutral position, in a motor they are short circuited before they arrive at the neutral position.

8. The Load to be Carried by Armatures.

Assuming that a machine is properly designed, a position can be found for the brushes where the sparking is *nil*. If, on the other hand, the machine is badly designed, or if the current carried by the armature is too great, a sparkless collection will be found impossible, from the excessive distortion produced by the armature field. There is for every machine a certain limiting number of ampère-turns which the armature can carry, beyond which we cannot go without effecting some radical alteration in the design.

Now it is manifestly of the very greatest importance to know to what extent an armature can be loaded for a given field. It will be understood that the cross induction—that is, the lines of force which can be induced by the armature winding—depends upon the number of ampère-turns on the armature, and upon the magnetic resistances of the various parts which make up the cross circuit. Undoubtedly the induction follows the same law for the cross as for the forward circuit, though it is difficult to determine with accuracy either its magnitude or direction. But we know that by far the largest portion of the resistance is encountered in the air gap, and that increasing the length of the gap diminishes almost in reverse ratio the cross induction. We know also that the cross induction depends on the width of the air gap, for the greater the cross section of the gap, the greater the cross induction for a given cross section of armature core and a given magnetising force. It depends also, but to a less extent, on the induction in the core.

The forward induction we can give to a machine may be considered as proportional to the cross section of the armature core; for if the magnets are large enough, with sufficient magnetising force, we can always in normal types get an induction of 16,000 to 17,000 C.G.S. per square centimetre.

Now the distortion of the field depends upon the ratio of the cross to the forward induction. In actual machines we have not, of course, two sets of lines crossing each other, but the tendency to produce a cross induction is manifested in a distortion produced in the forward lines. It is to prevent the sparking which would ensue, due to this distortion, that a lead is given.

The cross induction may be reduced in double-magnet machines by thinning down the magnets as shown in Fig. 3. This illustrates a type of magnet I designed in 1884, which gave first-class results, to the great surprise of many who believed that no good effects could be obtained without massive pole-pieces, irrespective of the configuration of the magnetic circuit otherwise. For the reasons given in Section 3, it is undesirable to reduce the section of single-magnet machines with this object. Another plan for reducing cross induction is in making the air gap increase from the crown of the poles towards the tips, as was done by Messrs. Paterson and Cooper in the Lumley machines before I joined them, and as is done in some of the Manchester machines for another purpose.

As both forward and cross induction are proportional to the length of the armature, we need not consider that dimension here, but simply confine ourselves to the cross section of the armature and poles, as shown by the several drawings. A lead being given to the brushes, it will be observed that the convolutions lying between the two horizontal lines, a, b, and c, d, fig. 19, directly oppose the forward induction, along e, f and g, h, since the current flows in them in the opposite direction to the current round the magnets. The lines of force, which would be sent in an opposite direction, may be called the backward induction. This *per se* is of little consequence, as it can be compensated by additional turns on the magnets, but the distortion of the field, to which its existence is due, is of enormous importance.

It is not my intention to take up time with any calculations respecting the actual number of cross lines which would be induced by the current flowing in the armature, or to try and map out the exact distribution of the field as modified by cross induction. For the present I will be content with the statement—which is, of course, open to criticism—that, roughly, the cross induction is proportional to the ampère-turns on the armature and to the width of the poles, measured parallel to the

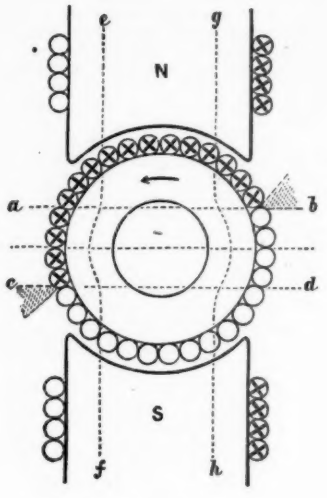


FIG. 19.

direction of rotation, and inversely proportional to the length of the air gap—*i.e.*, the distance between the polar surface and the surface of the armature core. Calling A_2 the ampère-turns on the armature, w, the width of the air gap, and l its length, the tendency to induce cross lines is measured by $\frac{A_2}{l}\frac{w}{}$; and since the forward induction is proportional to the radial depth of the core, r, for all sizes of machines, the ratio between the above value and r should be similar. In other words, the ampère turns which can be carried by the armature are proportional to the radial depth of the core and to the length of the air gap, and inversely as the width of the pole; whence

$$A_2 \propto \frac{r\,l}{w}.$$

For the purpose of showing to what extent some such relation as exhibited obtains in the machines now made, I have given in Table II. the dimensions of several taken at random. In the first column after the names of the dynamos comes the outside diameter of the armature core, which does not enter into our expression. Next come the ampère turns carried, followed by the radial depth in centimetres, with both of which we have to do. In column IV. is given the angle in degrees embraced by each pole, while columns V. and VI. give the length of the air gap and width of the pole. In column VII. is given a coefficient by which the right hand side of the equation must be multiplied, in

TABLE II.—Loads carried by Cylinder Armatures.

Name of machine	I. Outside diam. of arm. core.	II. Ampère turns on the arm.	III. Radial depth of the core.	IV. Angle embraced by each pole.	V. Length of the air gap.	VI. Width of the pole piece.	VII. Co-efficient.
DYNAMOS.							
1. Gramme ...	18·3	6,000	2·65	135°	0·85	23·0	61,265
2. Phœnix	22·2	6,500	2·85	115°	0·80	24·0	68,421
3. Phœnix	27·0	9,000	3·35	112°	0·96	28·5	79,757
4. Crompton ..	18·3	7,560	3·80	135°	0·96	23·5	48,700
5. Manchester	24·1	10,500	5·05	139°	0·80	31·0	80,569
6. Phœnix	33·0	13,500	5·10	115°	1·10	35·5	85,427
7. Kapp	33·0	13,020	5·30	140°	1·25	43·0	84,507
8. Phœnix	35·5	18,000	6·35	122°	1·20	40·6	95,905
9. Kapp	36·8	13,875	6·10	140°	1·25	48·0	87,344
10. Crompton ..	39·35	26,400	7·94	135°	1·95	51·0	86,959
11. Phœnix	43·0	23,000	8·90	115°	1·27	44·2	89,940
12. Phœnix	42·6	17,100	7·30	120°	1·27	47·0	86,689
MOTORS.							
13. Immisch ...	30·4	9,000	6·40	120° / 130°	0·96	35·2	51,562
14. Immisch ...	38·0	15,000	7·60	120° / 130°	0·96	43·5	89,432
15. Immisch ...	61·0	27,300	11·40	120° / 130°	1·63	70·0	102,840

order that for the sign of proportionality we can in each case substitute equality. According to the proposition put forward this coefficient ought to have the same value in all cases. The agreement is marvellous when we remember that in machines of the same size we have to vary the load considerably to suit different outputs, and that in the examples given the saturation may vary considerably. The disturbance due to cross induction bears about the same proportion in all; the similarity in this respect being, in fact, remarkable for machines so dissimilar otherwise. The machines Nos. 7 and 9 have iron wire cores, but Mr. Kapp has kindly given me the equivalent dimension of the radial depths were plates employed instead, and this is what appears in column III. The machine No. 4 is given because it is the one which departs most from my equation. The ampère turns on the armature are here so few—that is to say, there is so little copper and so much iron—that I at one time suspected it of being the very machine which Mr. Crompton confesses to having designed during Mr. Kapp's absence at Vienna.* In the machine No. 8 the coefficient has been since reduced by narrowing the poles. About the motors Nos. 13, 14, and 15 I shall have something to say presently. In these the edges of the poles are curved along their lengths, hence the two angles in column IV. The coefficient is calculated from the mean width.

Inserting what appears to be the mean value in column VII., we have for the ampère turns which may be carried by an armature the expression,

$$A_2 = \frac{r\,l\,85{,}000}{w},$$

which may prove very useful until we get something more exact. We have been taught by experience that diminishing the ampère turns, increasing the radial depth, increasing the air gap, or diminishing the width of the poles, reduces the distortion and cures its attendant evil of sparking. The equation states the same thing in another way, for it tells us that the ampère turns may be increased in proportion to the radial depth and to the length of the air gap, and inversely as the width of the poles. I do not wish for a moment to dogmatise on this subject. It is not pretended that the expression is complete, as there are doubtless many factors upon which the load depends. Amongst these are, obviously, the number of sections of the armature, the shaping of the pole pieces, and the general configuration of the magnetic circuit. But the equation is at least a guide, and if the coefficient 85,000 is not exceeded, the machine can certainly be made to run without sparking. The expression applies equally to armatures with more than two poles, only in the case of these the ampère turns given by it must be multiplied by the number of pairs of poles.

When speaking of the radial depth being increased, it is, of course, assumed that there is the same induction per square centimetre in the increased section of the core. Again, increasing the air gap is not supposed to diminish the induction, as additional magnetising force must be provided to keep it up to its original value. We conclude, then, that if the output of a machine of given carcase dimensions is to be increased—or, in other words, if the ampère turns on the armature are to be greater—the tendency to increased cross induction must be counteracted by increasing the resistance of the air gap. Some will doubtless be astonished to hear that greater output necessitates increased magnetic resistance.

Mr. Ravenshaw has a rule to the effect that in order to prevent sparking, in cylinder armatures the ampere turns must not exceed 35 times the total area of the core in centimetres, or in drum armatures, assuming the same induction per square centimetre, 70 times the area. The rule has been applied to the construction of several types of two and four-pole machines, but it does not seem to me universally applicable, since the number of ampere turns allowable depends not only on the area but on the relation of the two factors which make up the area.

Practical men must have rules of some kind. Without them their practice could not be continued for a single day. These rules, written or unwritten, are the results of experience which have been aggregated into some kind of applicable shape, but justification for which it would often be difficult to find on purely scientific grounds. We have to make our rules as we go along, engineering intuition and empiricism leading the way, knowledge and scientific accuracy following. We can speak with authority regarding the utility of a formula which we would be ill prepared to justify scientifically. It is because the rule here given has proved useful to me that I venture to suggest its use to others.

Regarding drum armatures I have not been able to get such full information; but in Table III. are given the diameters and ampère turns on the armatures of some well-known machines. There seems to be little agreement, at first sight, between the diameter and the ampère turns; but if these are plotted as abscissæ and ordinates respectively, it will be found that a straight line can be drawn through the intersection of the axes, giving a very fair mean of all the points with the exception of 5 and 7, which compared with the others are abnormally high. The relation denoted by this line is A_2 = diam. in centimetres × 570. It will be understood, of course, that the induction may be very different in these armatures, as well as the ratio between the external diameter and central opening. If we take the latter as ·4 of the diameter, the ampère turns are 1,900 times the radial depth of the core, in centimetres.

* *Journal Society Telegraph Engineers*, Vol. XV., p. 546, 1886.

TABLE III.—LOADS CARRIED BY DRUM ARMATURES.

	Name of Machine.	Diameter of Armature Core, in cm.	Ampère turns on Armature.
	DYNAMOS.		
1	Edison, No. 4	16·0	8,440
2	Edison, No. 5	18·0	10,330
3	Weston, 6 M.	18·75	10,488
4	Weston, 6 W.I.	18·8	11,200
5	Weston, 7 M.	21·8	16,400
6	Edison, No. 10	24·3	17,150
7	Edison, No. 20	24·3	17,260
8	Edison-Hopkinson	24·5	13,200
9	Siemens	29·2	17,600
10	Westminster	39·4	22,000
	MOTORS.		
11	Immisch	14·6	7,600
12	Immisch	17·2	9,000
13	Immisch	24·8	14,700

(To be continued.)

Physical Society.—February 21st, 1890.

(Prof. G. CAREY-FOSTER, F.R.S., Past-President, in the Chair.)

Mr. S. Evershed was elected a member of the society.

The following communications were read:—"On a Carbon Deposit in a Blake Telephone Transmitter," by Mr. F. B. HAWES. The author exhibited photographs of the interior portions of the transmitter on which the deposit had taken place. These portions consist of a metal diaphram and a highly polished carbon button, and a platinum contact piece carried by a German silver spring placed between them. The diaphragm presented a mottled appearance, due to the deposit, but the part which had been behind the German silver spring seemed comparatively clean. The deposits on the carbon button and German silver spring were much less dense than that in the exposed parts of the diaphragm, and the space near the point of contact between the platinum and carbon was free from deposit. The deposit was fairly adherent, considerable rubbing being necessary to remove it, and on examination under the microscope particles of copper and metallic crystals could be seen. The author believes the deposit due to some kind of bombardment of carbon particles, but was unable to say why it should occur, or why the varnished diaphragm should receive the greater deposit, although it was further from the carbon than the German silver spring.

Mr. C. V. BOYS said the photographs reminded him of a phenomenon he observed some time ago on a glass sheet, against which one terminal of a dry pile had been resting for some weeks. Just as on the carbon button, the glass near the point of contact was clean, and had a comet-shaped deposit formed around it. He could offer no explanation of the appearance.

"The Geometrical Construction of Direct Reading Scales for Reflecting Galvanometers," by Mr. A. P. TROTTER. In a recent paper "On Galvanometers," by Prof. W. E. Ayrton, F.R.S., T. Mather, and Dr. W. E. Sumpner, read before the Society, the opinion was expressed that proportionality of scale reading to current was very desirable, and the present paper shows how to bend a scale of equal divisions so as to give the required proportionality. Suppose the currents required to produce several deflections have been experimentally determined. A full size plan of the scale is then drawn, and radial lines from the points on the scale at which the observations were taken are drawn towards the centre of the mirror. Let these radii be numbered 0, 1, 2, 3, &c., commencing from zero azimuth. According to the procedure recommended, distances proportional to the several current strengths are marked off along the edge of a strip of paper, a few inches being left over at each end. Call the marks a, b, c, d, &c., a being the zero point. Two points on the radii, 0, 1, and equidistant from the mirror, are now found such that the distance between them is equal to that between a and b on the strip, and the points marked by five needles stuck in the board. The zero end of the strip is now fixed so that the marks, a and b, lie against the needles, and the strip is swept round until the mark c coincides with the radius 2, where also a needle is placed. Repeating the process gives a series of points which on being joined form part of a polygon. A line can then be drawn between the inscribed and circumscribing curves, which has the same length as the sum of the straight lines, and this is the curve to which the original scale may be bent, so as to give proportional readings. Diagrams showing such curves constructed from the calibrations of instruments, given in the paper above referred to, accompany the paper. The author showed that a family of curves may be drawn, each of which satisfies the required condition. Of the two limiting curves one is tangential to the usual scale line at zero azimuth, and the other passes through the vertical axis of the mirror. The flattest of the various curves is generally the most convenient.

Mr. J. SWINBURNE asked whether good definition could be obtained when such curved scale not equidistant from the mirror were used, and also whether it was not easier to divide a flat scale unequally, so that the readings are proportional to the current.

Mr. TROTTER, in reply, said Dr. Sumpner thought there would

be no difficulty as regards definition with the flat curves shown. He (Mr. Trotter) also added that a curved scale might be advantageous in reading the deflections from one side of a table, as the more distant part of the scale could be more nearly perpendicular to the line of sight. For such an arrangement, however, a parallel beam of light would be required.

"A Parallel Motion suitable for Recording Instruments," by Mr. A. P. TROTTER. This is a modification of Watt's parallel motion, in which the two fixed centres are on the same side of the line described by the "parallel point." The arrangement consists of two vibrating arms, one of which is twice the length of the other, and whose outer ends are pointed respectively to the middle and end of a short lever; the free end of the latter describes an approximate straight line. The motion was arrived at by considering the curve traced out by a point on the radius of a circle such that its distance from the circumference measured towards the centre is equal to the radial intercept between the circle and a tangent line. The equation to the curve is $r = 2 - \sec. \theta$ (conchoid of Nicomedes), and the radius of the osculating circle at the point where the intercept is zero is given as half that of the initial circle. This osculating circle, the author finds, practically coincides with the curve over a considerable angle (40°), and hence may replace this part of the curve; hence the motion. The author thinks the motion will be useful for recording barometers, ammeters, and voltmeters, as it is more compact than that of Watt, and needs no fixed point beyond the straight path.

Owing to the absence of Prof. S. P. Thompson, his paper "On Bertrand's Refractometer" was not read.

NEW PATENTS—1890.

2527. "Improved method for the regulation of the carbons in electric arc lamps by the expansion and contraction of metallic wires." O. CORNWELL. Dated February 17.

2654. "Improvements in the manufacture of electric cables." J. E. KINGSBURY. (Communicated by The Western Electric Company, United States.) Dated February 18.

2655. "Improvements in insulating electric wires." J. E. KINGSBURY. (Communicated by The Western Electric Company, United States.) Dated February 18.

2659. "Improvements in electric arc lamps for use in search light projectors and other purposes." THE HON. C. A. PARSONS. Dated February 19.

2660. "Improvements in lamp holders, or sockets, for incandescence electric lamps." R. A. SCOTT. Dated February 19.

2687. "The utilisation of a waste product for the means of producing electricity." A. W. ARMSTRONG. Dated February 19.

2688. "Improvements in or connected with electric wire running and appliances therefor." A. W. ARMSTRONG. Dated February 19.

2759. "Improvements in the lighting of railway trains by electricity." I. A. TIMMIS. Dated February 20.

2825. "Improvements in bases, covers, and fixings for electrical safety fuses, switches, and the like." W. WHITE. Dated February 21. (*Complete.*)

2838. "An automatic or coin-freed apparatus or attachment for use in connection with telephones." F. R. SIMMS. Dated February 21.

2843. "A new and improved telephonic receiver." H. C. BRAUN and A. F. LLOYD. Dated February 21.

2844. "Improvements in the construction of continuous current dynamo armatures." L. B. ATKINSON. Dated February 21. (*Complete.*)

2845. "Improvements in secondary batteries." E. T. MACKRILL. Dated February 21,

2876. "Improvements in safety apparatus and devices for preventing danger from high tension electric currents." H. E. WALTER. Dated February 22.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1889

85. "Improvements in dynamo electric machines." A. POLESCHKO. Dated January 2. 8d. The improved machine consists of an iron disc cut up in the direction of its radii into a large number of narrow sections. It revolves between pole pieces having the form of narrow sectors on the sides turned towards the disc which sectors so to speak compress the magnetic flux along the radius of the disc. A collector consisting of two brushes side by side rubs on the periphery of the disc and these can be adjusted to make and break contact with the radii of the disc as they approach to and recede from the pole pieces, either sooner or later as may be required; this adjustment can be made independently in front of and behind the pole pieces. Another brush collector makes contact with the radii at their inner ends adjacent to the axis. 3 claims.

282. "Improvements in conduits for electric mains." F. COATES. Dated January 7. 6d. The inventor constructs the conduit of cast iron, stone, earthenware, or other suitable material, which may or may not be insulated by any suitable enamel or composition and it is fitted with covers which can easily be removed. 3 claims.

342. "Improvements in or relating to the regulation of dynamo electric machines." W. M. MORDEY. Dated January 8. 4d. Consists in the employment of a small dynamo of any suitable kind, both machines being driven by the same motor and therefore subject to the same degree of variation. The additional dynamo is made to produce an opposing or partially demagnetising effect upon the fields of the main generator. At the normal speed the differential value of the main generator field currents is that of the normal field required. When a rise or fall of speed takes place the demagnetising current of the additional dynamo increases or decreases so as to neutralise the effect on the main generator of the variation of speed. 3 claims.

614. "An improved form of electrical locking switch." W. N. NAYLOR and W. J. NAYLOR. Dated January 12. 8d. A piece of metal, preferably of a right angular shape, is pivoted, or fixed in any equivalent manner upon a slate, ebonite, or other insulated base; upon the shorter arm or leg of the right angular or equivalent piece is formed a notch, and at or near the end of the longer arm or leg a hole or hook is formed to which a cord or equivalent is fastened. A check spring is attached to any suitable part of either the longer or shorter arm or leg, and a stop or stops are provided to control its action. Upon the same or a separate insulated block is a pivoted bar, fashioned at the shorter end from its axis so as to fit the notch before described; the longer arm is also drilled or otherwise formed to receive a cord or equivalent, and a suitable check spring is provided operating in such a manner as to securely interlock the two bars. Suitable terminals are provided for forming electrical connection to the interlocking device described, and provision is made for the insertion of a fusible or other cut out. The switch being connected up to the main or branch leads or equivalent circuit by means of the terminals provided therefor. The current will flow through the fusible or other cut out, the lamps, lamp or equivalent, returning through the interlocking device, or in a direction reverse to this. By pulling the cord attached to the arm having the notched end the bar or equivalent shaped piece engaging therewith is released, and the circuit broken and by operating the cord attached to the bar or equivalent engaging therewith it can be again restored. 3 claims.

1537. "Improvements in or relating to electric lighting." A. J. BOULT. (A communication from Dr. S. Doubrava, of Austria.) Dated January 28. 8d. Consists in employing an alternating current produced by charging and discharging condensers while dynamos for continuous currents are employed. The continuous current produced by the dynamo is changed into alternating currents in quick succession by a special apparatus, and this consists of a series of insulated metal segments, which are arranged in an iron box similar to the commutators of dynamo machines. One third of these blades is connected with a metal disc on one side of the apparatus, the second third with a similar metal disc on the other side, and the other third is entirely insulated, so that each of the segments which is in contact with one of the sides is perfectly insulated from the next segments which are connected to the other side. Two sliding contacts bear one against each of the metal discs at the sides of the apparatus, and by means of this apparatus it is possible to interrupt the current several thousand times per second. Alternating currents of opposite direction can be produced by this apparatus (called the "disjunctor") and the condensers in two ways—viz. (*a*) by charging and discharging the condenser, or (*b*) by charging the condenser successively in opposite directions. 4 claims.

7919. "Improvements in apparatus for making certain articles of pottery ware, such as electric lamp roses, switches, fuse blocks, and the like." R. T. GROCOTT. Dated May 13. 8d. Consists in making a die which will form the article, pierce it with the required holes, and form a screw thread upon it at one operation. 2 claims.

9977. "Improvements in apparatus for giving motion to reciprocating parts, such as percussive tools, by means of electricity." W. P. THOMPSON. (A communication from abroad by H. N. Marvin.) Dated June 18. 6d. Claims:—1. A source of electric currents consisting of a field magnet and an armature revolving in the field of said magnet, a collector with which one terminal of the armature coils is connected, a brush at all times in contact with said collector, a second collector in connection with the other terminal of the coils, and two contact brushes alternately making contact with said second collector, each of said brushes connected to an independent circuit, substantially as described. 2. A source of electric currents, consisting of a field magnet and an armature revolving in the field of force of said magnet, a collector with which one terminal of the armature coils is connected, a contact-brush at all times in contact with said collector, a second collector in connection with the other terminal of the coils, two contact brushes alternately making contact with said collector, conductors leading from the latter brushes respectively, and two solenoids or electromagnets respectively connected in said conductors, and a conductor leading therefrom to the first-named contact brush.